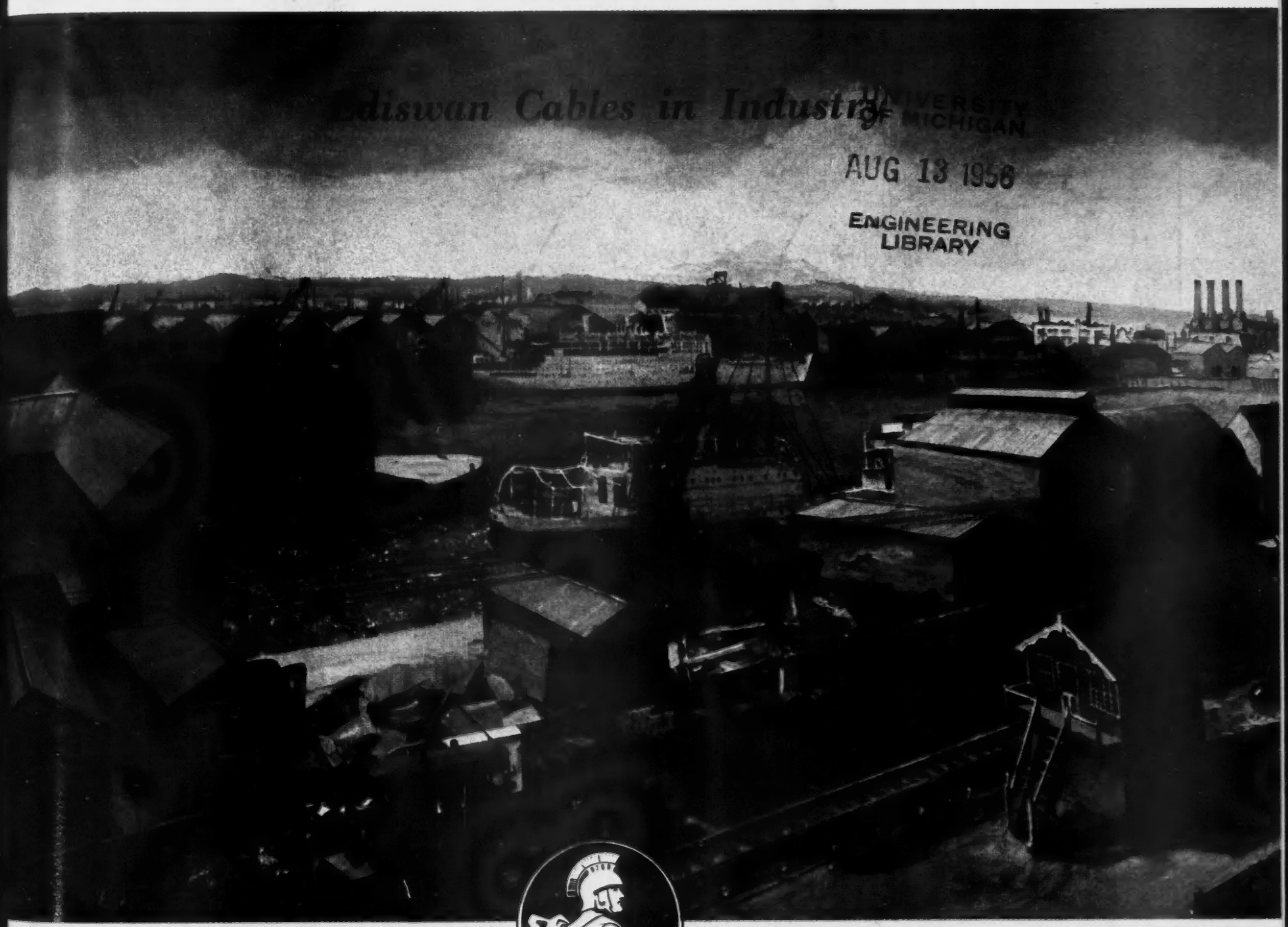
ELECTRICAL REVIEW



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ELECTRICAL REVIEW

Managing Editor: HUGH S. POCOCK, M.I.E.E.
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27 JULY 1956

In This Issue

143 KEEPING AN EYE ON THE BALL
145 AUTOMATIC RESISTANCE WELDING
149 ELECTRICAL PROGRESS IN IRELAND
151 INDUSTRY AND THE HOUSE
152 SUPERGRID TRANSFORMERS
153 OVERSEAS ELECTRICAL TRADE
155 LETTERS TO THE EDITOR
156 CARRINGTON POWER STATION
161 B.T.H. SUMMER SCHOOL
163 PARLIAMENTARY REPORT
164 INDUSTRIAL NEWS
167 NEW ELECTRICAL EQUIPMENT
168 GENERATION AND DEVELOPMENT
170 PERSONAL AND SOCIAL
173 VIEWS ON THE NEWS
174 FINANCIAL SECTION
178 BERKELEY NUCLEAR STATION
179 INDUSTRIAL POWER FACTOR CORRECTION
184 NEW PATENTS
185 CONTRACT INFORMATION

109 *CLASSIFIED ADVERTISEMENTS*
122 *INDEX TO ADVERTISERS*

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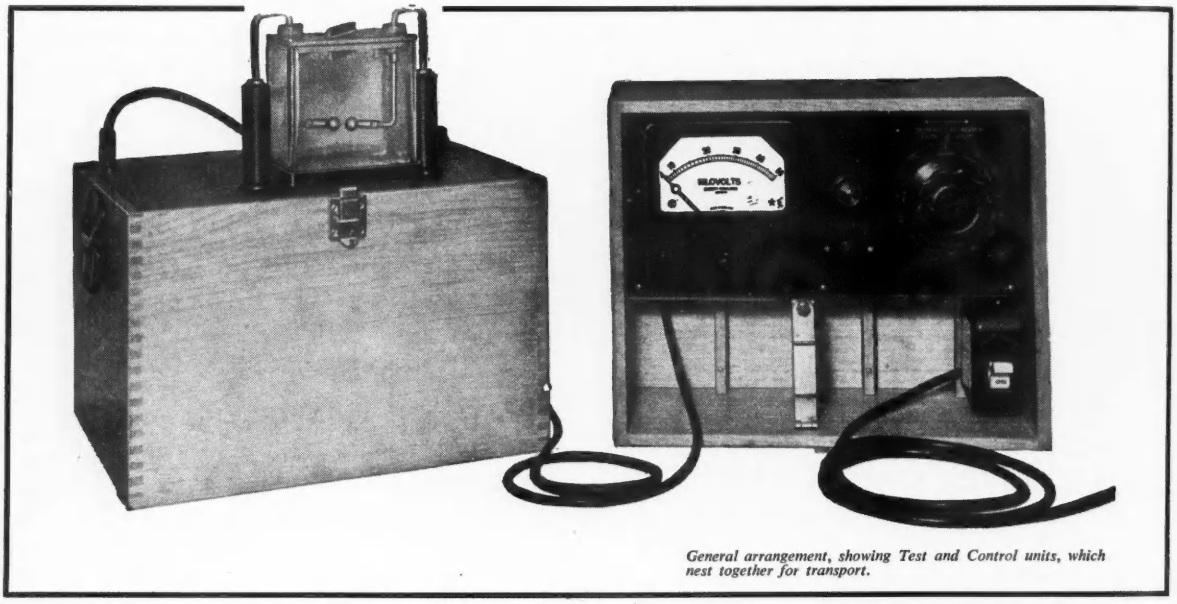

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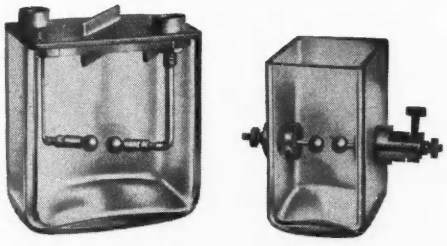

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ELECTRICAL REVIEW

27 July 1956 Vol. 159 No. 4 Established 1872

Keeping an Eye on the Ball

THERE seems at present to be a lull, in the engineering world at any rate, in both the written and verbal uses of the newly coined and fashionable word automation, but still the confusion, which its indiscriminate use has caused, persists. This presents a favourable opportunity for us to attempt to put automatic control in its true perspective and thereby, we hope, to remove at least some of the confusion. Automatic control can be traced well back to many of the essential manual-operation feats of ancient times, as, for instance, the control of the manual handling of materials in the building of the Egyptian pyramids. It is as well for engineers, at any rate, to bear such ancient developments in mind because this helps one to avoid being mentally jostled into a state of bewilderment as automatic control developments reach a stage not earlier envisaged.

From the truly engineering and industrial points of view, however, we can safely say that automatic control started right from the beginning of the industrial revolution, the evolutionary results of which are still with us to-day, progressing at such an ever-increasing pace as to lead some of us to the misleading impression that automation heralds a second industrial revolution.

At first, in the industrial revolution period, automatic control schemes were all mechanical in character, and the governor developed for the steam entry to the engine which in the first place brought the industrial revolution into being is a very good example of such automatic control. Since then, however, automatic control developments have become ever-increasingly electrical in character, and for many years now the terms automatic control and electrical control have been practically synonymous.

But that is by no means the end of the story, for electrical automatic control development has proceeded at a high rate of acceleration, particularly since the introduction of the thermionic valve and the resulting developments in electronic control. Certain sections of industry have been so taken unawares by the pace of things that some mysterious unknown quantity appeared to be among us and to need some explanation. The introduction of a new term seemed to give some satisfaction where the need existed, and to that extent it may have been useful. It is not an engineering term, however, simply because it is the job of the engineer to keep a vigilant eye on things all along.

In making these observations we do not wish to give the impression that we think that all forms of control are now subordinated to electronic control. In the main there are now two wide fields of electrical control—electromagnetic and electronic—and there is a useful field of application for each of these. Nor would we ignore that there is a useful field for lesser forms of electrical control, such as thermal-electric devices, and hydraulic and pneumatic systems which may be entirely non-electrical must also be included in any survey of the subject.

THE CROSS-CHANNEL LINK

Reports have appeared in the lay Press of a change in the ideas or plans of the joint committee representing the Central Electricity Authority and Electricité de France in respect of the proposed cross-Channel transmission scheme to link up the electricity transmission systems of the two countries. Instead of transmission of energy across the Channel in the form of a.c., as it has been felt for a long time would be the case, it appears that after all d.c. transmission is more likely to be adopted. It rather looks as though the decision, if it is a decision, has really been made on the score of economics, although at first glance this is a little surprising because a.c./d.c. conversion plant will have to be installed at each end of the link, but it is said that the actual cable for d.c. transmission is likely to be simpler and less costly than for a.c. transmission.

It would appear that the new plan has a bearing on what has been done in the way of d.c. submarine cable transmission between Sweden and the island of Gottland. This Scandinavian scheme appears to have led to Sweden being the only country with experience in the production of the type of rectifier equipment necessary for such a project, and messages from Sweden about the probability of that country securing orders for the cross-Channel link are possibly responsible for the scanty information which is obtainable, for it appears that no information is available from either the C.E.A. or Electricité de France.

ELECTRICAL RESEARCH

The recently published first issue of the house journal of the Electrical Research Association named "Co-operative Electrical Research" (*Electrical Review*, 13th July) reminds us of the remarkable services which the E.R.A. has, over the years, afforded the electrical industry as a whole. As we have said before, in common with practically all research work, that of the Association appears largely in the form of commercial and utilitarian plant and equipment of one sort or another, and in saying this we have in mind particularly the magnificent work done in the past years by the Association in connection with arcing control in circuit-breakers. We regard the work of the Association as one of the outstanding examples of co-operation, not merely with the electricity supply and manufacturing industries, but also with such organisations as the Institution of Electrical Engineers, the National Physical Laboratory, and the British Iron and Steel Research Association, and with the universities.

KARIBA GORGE

In last week's issue we gave details of the contracts awarded for the first stage of the Kariba Gorge hydro-electric scheme in Rhodesia. Although the largest contract, that for civil engineering works, has gone to an Italian consortium, this country's heavy electrical industry has secured the contracts for all the plant. The names of the unsuccessful tenderers are not quoted but their number is given in each case and there can be no doubt that heavy international competition took place. Since only five out of an ultimate twelve units have so far been ordered there can be every hope that British manufacturers will substantially increase their share of the contracts when the scheme is completed.

The plant contracts let to British firms aggregate over £5 million, and of the transmission line contract of nearly £10 million let to an Italian concern it is estimated that £4 million will be spent here on insulators and conductors: the switchgear contracts, which will be substantial, have yet to be let. When it is considered that both the civil engineering contract and the overhead line contract are made up very largely of local labour and materials it will be realised that an important share in terms of exported goods has undoubtedly come to this country. Nevertheless, it is a great pity that the prestige value of doing the complete job will be lost.

BOILER FOULING

An obstacle to rapid increase in thermal efficiency of new British power stations, as affected by steam temperature, has been the presence of appreciable percentages of chlorides in many types of coal. With sodium and potassium salts these tend to form alkali-bonded fly-ash deposits on the high-temperature surfaces of the superheater zone. This characteristic is unfortunately found especially in the expanding East Midlands coalfields from which an increasing proportion of new C.E.A. plant is expected to be supplied. Nevertheless, the intention is to install in this region some of the most advanced designs of new high-temperature plant. This bold approach indicates confidence in the results of the investigations now being carried out by the Fuel Research Board and by the Boiler Availability Committee, reports of whose recent work have been issued this week.

ELECTRIC WELDING AND PRODUCTION

The article "Automatic Resistance Welding" by Mr. A. G. Galle published in this issue focuses attention on the great part which electric welding is playing in increasing production. As an example of how readily the resistance welding machine fits into the industrial production line, we quote the following from the article: "To weld two pieces of number 20 gauge mild steel sheet, a modern pneumatic machine will close its electrodes, build up to the required electrode pressure, start the welding current flowing, terminate the flow of this current after one-tenth of a second, maintain the electrode pressure for another tenth of a second to forge the weld, and remove this pressure and open the electrodes again, all in a total of three-tenths of a second." All engineers and production men, we think, will agree that such a cycle is a magnificent feat which emphasises the great part welding technique is playing in increasing production in nearly every modern industry.

The next in our series of illustrated surveys of domestic electrical equipment (3rd August) will deal with hair dryers. Particulars to be given in tabular form will include details of type, weight, loading, price, purchase tax, etc. On 24th August blankets and pads will be reviewed.

Automatic Resistance Welding

The Development of Special-Purpose Machines

By A. G. GALLE, A.M.I.E.E., M.I.W.*

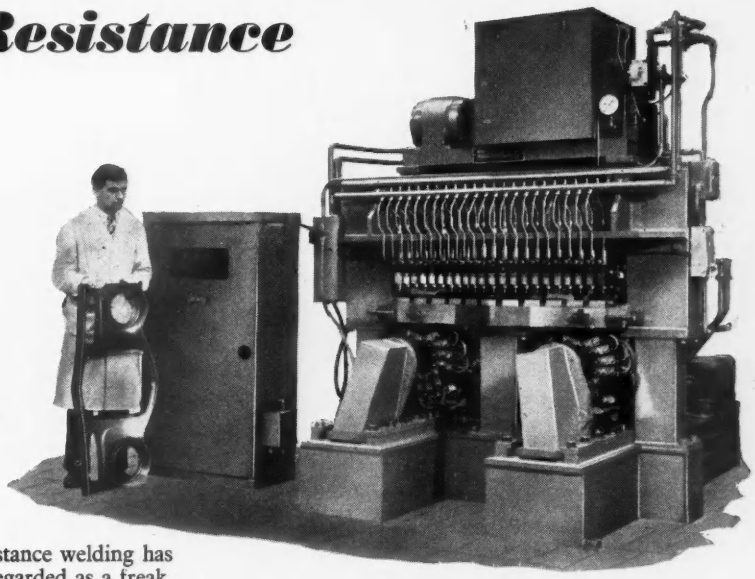


Fig. 1.—Small multi-head welding machine

IN the last 20 years the science of resistance welding has developed rapidly. Before that it was regarded as a freak and with great suspicion; nowadays it is thought of as the only possible means of quick fabrication.

The later history of the spot welder is interesting. Pedal operated machines with a tapping switch on the transformer primary for heat control, a hand-nut to adjust the electrode spring pressure and no timer died out before the war, except for jobbing work. They were replaced by pneumatically operated machines fitted with timers of either the condenser discharge or electronic type, and an electro-magnetic contactor.

These machines had a good run but as they got larger the contactors would not stand the increasingly heavy primary current, or the speed of operation. This was overcome by the advent of the ignitron contactor or pair of self-igniting mercury vapour tubes connected back to back. High primary currents and high speeds could then be used with much improved welding results.

The rather crude heat steps of the primary tapping switch were improved later by the addition of thyratrons to the ignitrons and " phase shift " heat control to give infinite adjustment by the turning of a small potentiometer. The firing of each ignitron as it starts a cycle is automatically delayed an exact amount or angle and the resultant primary current is controlled with accuracy.

Following on this development came pneumatically or hydraulically operated spot, seam or projection welders with electronic timers and water cooled ignitron contactors and these are likely to stay for a long time.

Nowadays, the development of resistance welders is more in the field of applications than machines, with the exception of control of the waveform of the welding current, referred to later in this article.

Multi-Head Machines

To make a spot weld on an ordinary spot welding machine, the components are placed between the electrodes and a foot switch is operated. Welding is automatic and exceedingly fast.

To weld two pieces of 20 gauge mild steel sheet, a modern pneumatic machine will close its electrodes, build up to the required electrode pressure, start the welding current flowing, terminate the flow of this current after a tenth of a second, maintain the electrode pressure for another tenth of a second to forge the weld, and remove this pressure and open the electrodes again, all in a total of three-tenths of a second. This gives a first-class weld on clean material.

However, if 30 welds are required on a 20 gauge fabrication of two pressings, the operator has to position this assembly 30 times and make a weld at each position. On normal easy weld runs a good operator is capable of making a weld and repositioning 15 times a minute continually over the day, even though the machine itself is capable of reaching 200 spots per minute, and this means that 30 complete fabrications can be produced in an hour.

If this 30 weld assembly is produced by using a special-purpose multi-head machine the two pressings are positioned in a fixture only once and 30 sets of electrodes close all at once: the multi-transformers are grouped over the three phases and the welds " rippled " piano-fashion in threes, one lot after another. If the finished welded assembly is ejected automatically from the fixture, leaving the operator free to load only, outputs of up to 600 assemblies an hour continuously are possible, 20 times faster than with the simple machine.

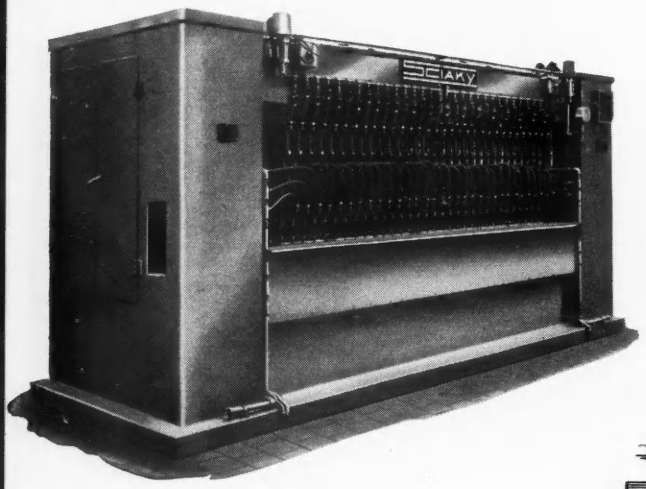
It is also worth recording that the electrodes will have 30 times the life as only one weld per assembly is made instead of 30; the load is distributed over the three phases, not taken from a single phase; as each secondary circuit is tailor-made it is very short and this ideal condition keeps the power factor high; all welds are exactly in the required position; and distortion is reduced to a minimum as all welds are made together.

Fig. 1 is a photograph of a small multi-head machine that was made to weld two round stiffener rings to take the headlamps, and an angle stiffener, on to the bottom of a front panel of a car body, with a total of 46 welds.

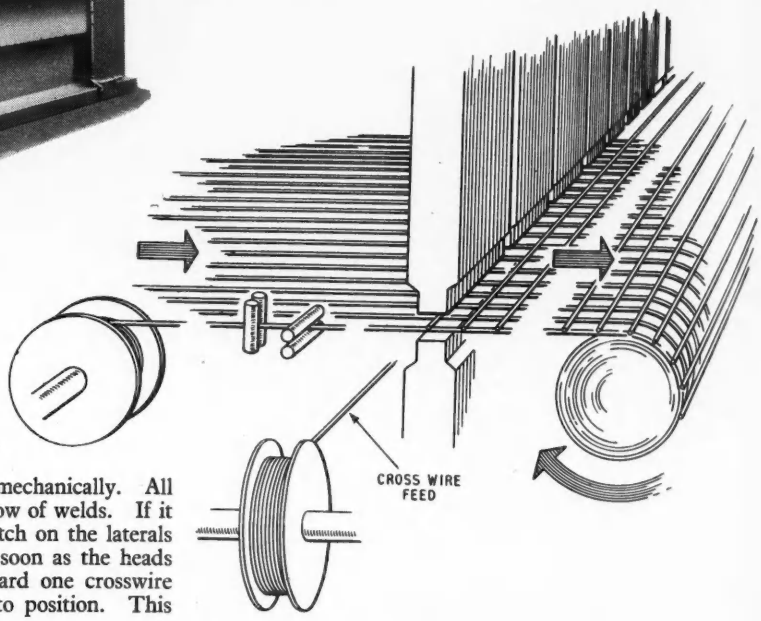
A machine for welding wire mesh for road reinforcement is shown in Fig. 2. This is possibly one of the best examples of automatic resistance welding with multi-head machines. The mesh is made generally with 3in, 6in, 9in or 12in pitch crosswise or laterally, and uses $\frac{3}{16}$ to $\frac{1}{2}$in diameter wire.

Fig. 3 shows diagrammatically the operation of the machine. The lateral wires are fed through straighteners under the row of pneumatically operated weld heads and

* Midlands Application Engineer, Sciaky Electric Welding Machines, Ltd.



Above: Fig. 2.—A machine for welding wire mesh for road reinforcement



Right: Fig. 3.—Diagram showing the operation of the wire mesh welding machine

an 8ft crosswire is shot into position mechanically. All the heads close together and make the row of welds. If it is required to make mesh with a 6in pitch on the laterals then every other head is shut off. As soon as the heads open the lateral wires are moved forward one crosswire pitch and another crosswire is shot into position. This pitch can be varied to what is required.

Speeds of 50 crosswires or 1,600 actual welds per minute continuously are common on the smaller wire gauges with smaller crosswire pitch centres.

Simple changes to existing methods can make great changes to production. Take the fabrication of two rectangular pressings such as the two half pressings of a radiator. To guide these through an ordinary circumferential seam welder it is not practicable to weld at speeds over 8ft per minute and taking into consideration loading and unloading times, speeds of 4ft per minute continuously are normal over the day.

If, however, two pairs of seam welders facing each other are used and two sides are welded at once, the components can then be turned through 90 deg mechanically and passed through a second pair of machines. The radiators can follow each other with a small gap between and it is possible to get welding speeds of about 16ft per minute continuously or four times as fast as before, still from one loader. A dual machine of this kind is illustrated in Fig. 4.

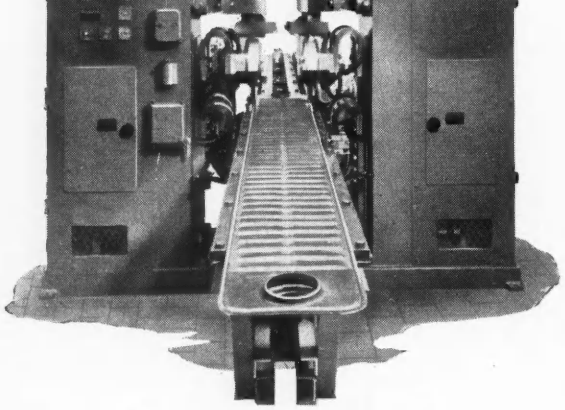


Fig. 4.—Dual seam welder working on radiators

Waveform

It has also been found essential to use a secondary current with a controlled waveform for important heavy-duty welds. To explain exactly what this is, Fig. 5 (a) shows an oscillograph of an ordinary single-phase spot weld lasting for 5 cycles. It can be seen that the welding current rises from zero to maximum in $\frac{1}{200}$ sec. It then drops to zero, and rises to maximum negative during the third $\frac{1}{200}$ sec and so on during the 5 cycles, or $\frac{1}{10}$ sec of welding time. These relative bursts of current tend to either blow the faces of the electrodes or damage the surface of the material.

Fig. 5 (b) shows an oscillograph of a similar weld but with waveform control. The maximum is not reached until the welding current has been flowing for $\frac{3}{50}$ sec. Thus the current rise is twelve times slower but the same amount of heat is generated in less time.

To a lesser degree the decay of the welding current is important; referring again to Fig. 5 on the ordinary single-phase spot welder, the time of the decay is fixed, i.e. it is the last half cycle or $\frac{1}{200}$ sec again. This sharp decay tends to cause cracks round the weld and the ideal is to have a control over its drop.

This control over the waveform is obtained by means of an electronic device developed by the author's company and converting the three-phase supply into d.c. pulses first positive then negative; in this case for a duration of $\frac{1}{10}$ sec with a single pulse for each weld.

This welding current waveform control is also helpful in three other directions: it prolongs electrode life,

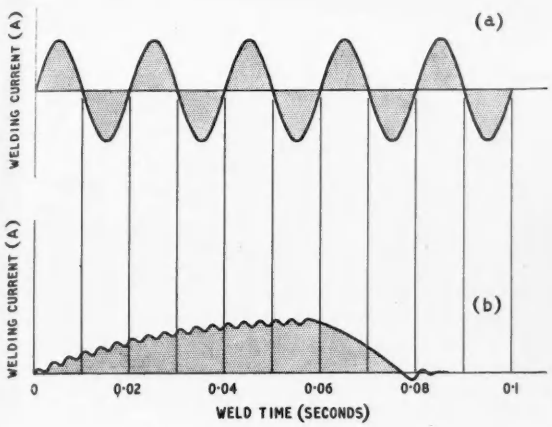


Fig. 5.—Current in the welding cycle

improves the power factor and spreads the load over the three phases. The reason for the much longer electrode life is due to the slow rise of welding current and reduction of "pick-up" from the stock being welded. This rise being twelve times slower is much kinder to the hard worked electrode faces.

The power factor is improved because the welding load is now a d.c. pulse, the induction is much reduced and the power factor very near unity. Finally, to produce the d.c. pulse, power is drawn equally from three phases and balance is obtained.

The fact that the load is balanced from three phases and the power factor is high, makes a large difference in phase line demand compared with the single-phase machines.

To give an example from two machines, both with a 48in reach, both welding 14 gauge aluminium alloy aircraft panels: to get satisfactory welds the single-phase machine was fed from two of the outers of a three-phase, 400 V, 50 c/s supply and drew 2,000 A for 6 c/s (800 kVA) with a power factor of 0·32. The three-phase machine drew 220 A per phase for only 4 c/s (150 kVA) at a power factor of 0·95, and made a weld which withstood a tensile load 15 per cent higher than the other machine due, no doubt, to the fact that the longer weld time of the single-phase cycle was annealing the material round the weld.

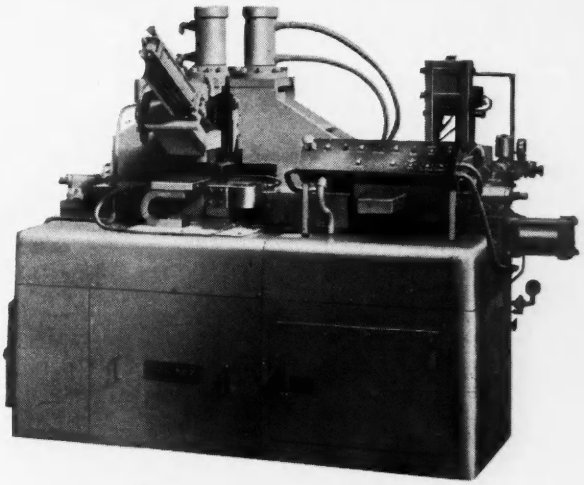


Fig. 7.—A strip flash welder and weld spue stripper

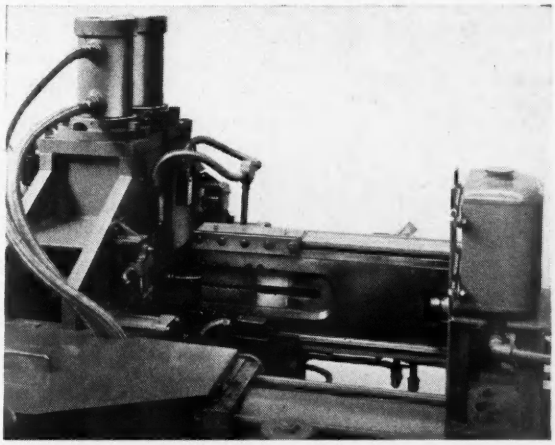
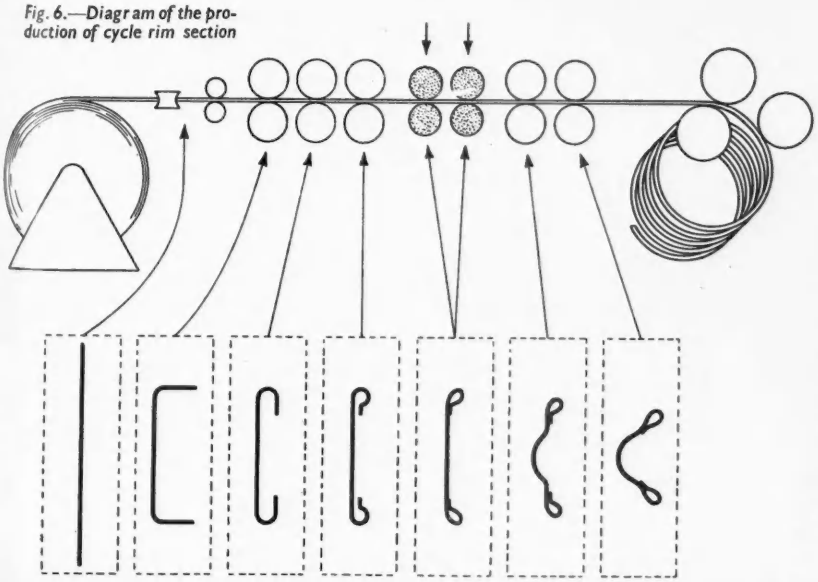


Fig. 8.—A close up of the spue stripping cutters in the open position

Fig. 6.—Diagram of the production of cycle rim section



The difference in costs of the installations in mains, power transformers and switchgear, both h.v. and l.v., for two types of machines is considerable: a second glance at the above figures will give the reader some idea on this point.

It is naturally important that the welds are all 100 per cent and everything possible is done to ensure this; one item is a photocell to check "colour" temperature as the electrodes lift and uncover the weld.

It is sometimes economically sound to add other operations besides welding into one large transfer machine to cut down handling costs. For instance, a cycle rim section rolling and seam

welding machine consists of some four or five heads forming the section from strip before the welding station, followed by two more stations where the final section is welded, and then a circling station where it is coiled into the correct diameter in a huge corkscrew roll. Each turn is cut off at the correct length and flash welded into a complete rim by another machine. The process is shown diagrammatically in Fig. 6. These machines can produce 20ft of rim per minute continuously.

A tube mill is not dissimilar to this and it is interesting to note that one of the limitations to the speed of welding tube is the 50 c/s ripple of the supply.

Such a supply gives 100 pulses of current per second and at 100ft per minute, 20 inches pass through the welder per second, giving five welds per inch. Good welded tube needs more welds per inch than this, so rotary frequency changers are generally added, and as the welder has single-phase transformers, the rotary set generally consists of a three-phase synchronous motor coupled to single-phase 150 c/s generators.

Another problem on this type of machine is to pass the very heavy welding current (about 50,000 A) from the welding transformer to the pair of rotating welding wheels.

As these electrode wheels are used, they slowly decrease in diameter, especially after trimming, making it impossible to drive them at the synchronous speed of the tube forming wheels. In consequence the welding wheels must be idlers and rotate as freely and with as little inertia as possible.

There are two main methods of achieving this. The first is by using a special rotary transformer with the secondary directly connected to the wheels, slip-rings on the primary, and the whole unit mounted on ball or roller bearings. The main disadvantages of this method are that the inertia is high and it is difficult to connect the water cooling supply to the rotary transformer without leaks. The second and possibly the best method is to use a fixed transformer and large area mercury baths from which to "pick-up" the secondary currents. With this method there is no friction of the primary slip-rings and no water glands are needed, the wheels are mounted in roller bearings and the only inertia is that of the wheels themselves.

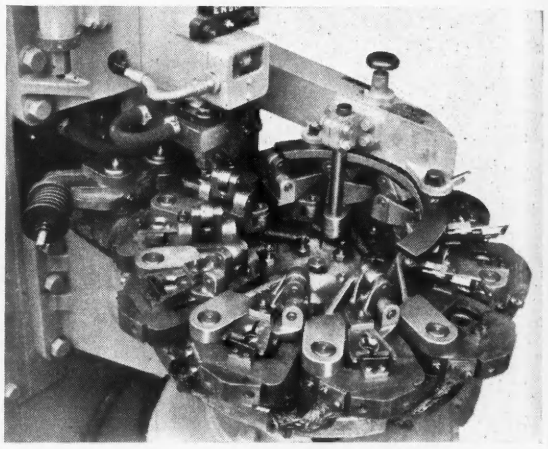


Fig. 9.—A ten station indexing resistance welder

In order that both a cycle rim seam welder or a tube mill can be run continuously without stopping, storage racks or slack pits are arranged in between the machine and coils of rim strip, together with a strip flash welder and weld spue stripper; and the coils of strip are joined into one endless strip. Fig. 7 shows a photograph of a typical machine, and Fig. 8 shows a close-up of the spue stripping cutters in the open position. A new coil of strip is flash welded and stripped in about two minutes, and to be safe about three minutes' run of strip, or 450ft, is stored for this period. Flying saws or crops cut off the tube in the required lengths while it is travelling.

Another form of automatic resistance welding is the rotary table or dial feed machine, having usually ten stations, that is ten sets of locating fixtures mounted round the table. By means of a Geneva drive the table pauses at ten positions during one revolution. During these pauses welding may take place at one, two, three or four stations, loading at one, two or three stations, and ejection or unloading automatically into a chute just after the last welding station. These machines are only used for small fabrications, otherwise the size of the machine would be very great.

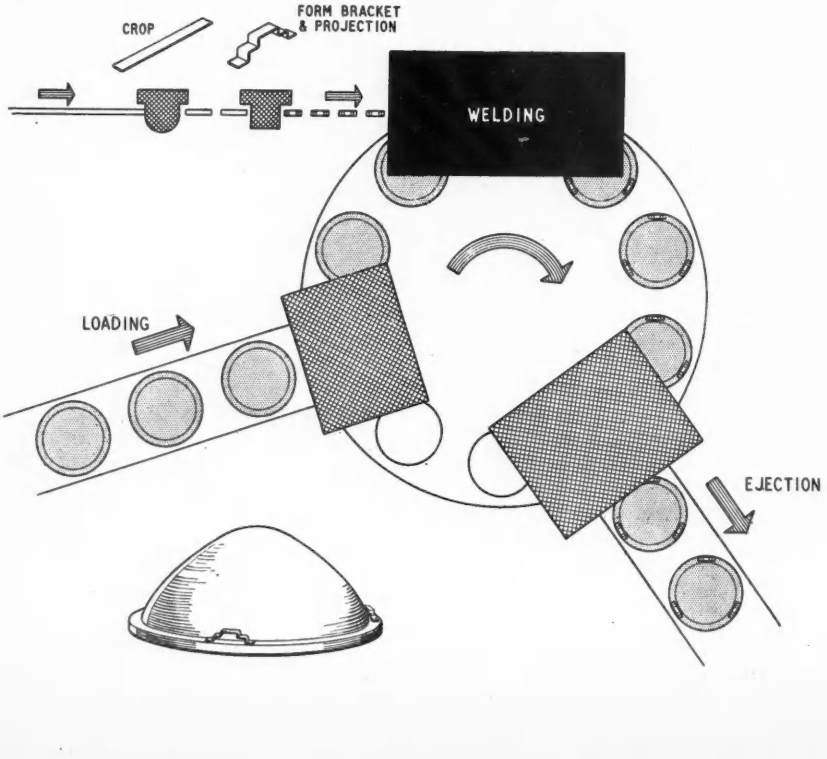


Fig. 10.—Pictorial representation of the work carried out by the machine in Fig. 11

Empty fixtures are passing the loading positions continuously and can be loaded during the welding and ejection periods. On simple fabrications as many as 3,000 per hour have been satisfactorily produced continuously by this type of machine. One operator can just manage to load at this speed if the article is of a simple nature but in many instances the loading is done automatically from hoppers and an operator can feed four, five or six machines.

Fig. 9 shows a typical ten station indexer table in its

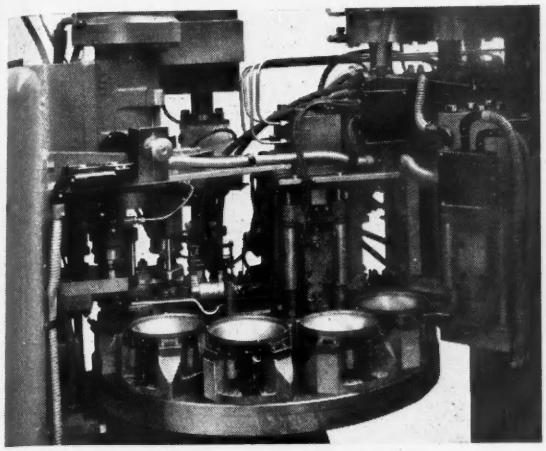


Fig. 11.—Another indexing machine in use

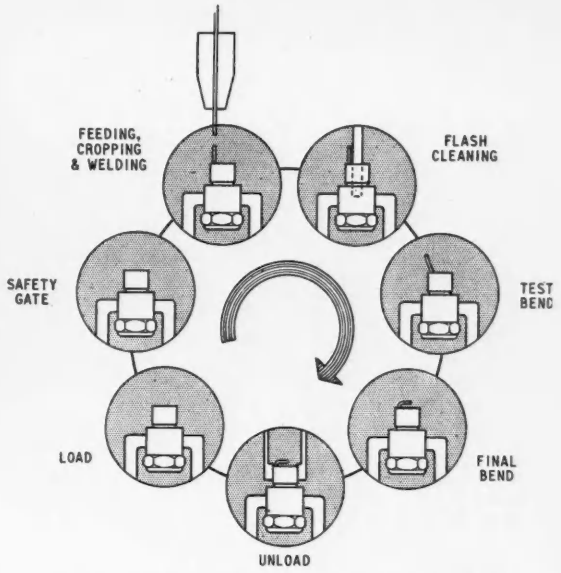


Fig. 12.—Work on a sparking plug in an indexing machine

simplest form; loading can be done at any of the three stations nearest the camera.

Fig. 11 shows a machine putting three clips on the back of car headlamp reflectors, but in this case on each movement of the indexer drive, a blank is cut off from a coil of strip and bent to the correct form before being dropped automatically into the welding position. The operation of this machine is shown diagrammatically in Fig. 10.

Another interesting machine of this type is used in the production of car engine spark plug bodies. The sequence is shown in Fig. 12. The bodies are dropped into dies at the loading station, and the earth tag wire welded to the body and cut off to length at the next station. A broach cleans out any welding spue from the bore of the body at the third station. At the fourth station the wire is test bent to check the weld, at the fifth it is bent to its correct form, and finally ejected down a chute.

There is no doubt that the use of these special purpose welding machines, in conjunction with the mechanical handling gear to cut out the human element, is very rapidly increasing. The only objection to them is that a change of design of the article being produced generally means a re-design of the machine, possibly using most parts such as transformers, air cylinders, electrode blocks, secondary jumpers and control gear but involving an entirely new frame to locate the weld heads in their new positions.

If the design change is not too large the old frame can sometimes be used again. On multi-head welders the heads are made to a standard with a single bolt to mount them on the frame. To mount them at the right angle to get the weld in the correct position a " doughnut " is used. This is a flattened ball of mild steel with a hole in it to take the weld head bolt. This " doughnut " is bolted to the head first and the head is temporarily clamped in the exact position and the doughnut arc-welded to the frame.

Most of these special purpose automatic machines are a mixture of electric, pneumatic, hydraulic and mechanical devices dove-tailed together and designed so that the parts can be serviced easily and quickly. All such parts as electric timers and relays, are arranged to plug in for quick replacement. Shut-downs must not occur as these are generally key machines and good maintenance planning to anticipate faults is essential.

Electrical Progress in Ireland

In its 29th annual report (for the year to 31st March last) the Electricity Supply Board, Ireland, records that a high rate of activity continued throughout the period. The number of consumers increased by 41,287 to 503,188 and sales of electricity rose by 9·6 per cent to a total of 1,306·6 million kWh. Under the domestic tariff (531·23 million kWh sold) the rate of expansion was 10·8 per cent and a noteworthy development was the 13·8 per cent increase in consumption for night storage heating, making the total under this head 85·7 million kWh. Motive power supplies were 7·1 per cent greater at 430 million kWh.

Under the rural electrification scheme supplies were given to a further 99 areas each of approximately 28 square miles. Additional rural consumers numbered altogether 34,257. As foreshadowed in the previous year's report, the 50 per cent subsidy granted for rural electrification was terminated with retrospective effect.

Rainfall was somewhat less than average, and hydro-electric production amounted to only 487 million kWh as compared with 590 million kWh in a year of average rainfall. This reduction resulted in an extra expenditure of approximately £200,000 on fuel. Peat was utilised to the full extent to which it was available, and produced 360 million kWh. Oil was largely substituted for coal in the other stations. The installed generating capacity was increased from 452 MW to 512 MW by the placing in commission of two 30 MW sets at the Ringsend (Dublin) station.

The average price per kWh sold remained unchanged at 1·92d. Revenue from the sale of electricity increased by £942,547 to £10,464,808 and, having made provision for interest, repayment of advances and plant renewal, there was a net profit of £184,523. With the balance brought forward and profits on merchandise and installation trading, there was a surplus of £290,961. Part of this has been used to write off the expenditure incurred on the

STATIONS UNDER CONSTRUCTION OR PLANNED

Station	kW	Probable Commissioning Year
Ringsend (coal- or oil-fired)	30,000	1956
Ferbane (peat-fired)	60,000	1956–57
Four hand-won-peat-fired stations	20,000	1956–57
Arigna (coal-fired)	15,000	1957
Lee (hydro)	27,000	1957
Clady (hydro)	4,000	1958
Lanesborough (peat-fired)	20,000	1957–58
Rhode (Derrygreenagh) (peat-fired)	40,000	1959–60
Shannonbridge (Blackwater) (peat-fired) ...	40,000	after 1960
Bellacorick (Oweninny) (peat-fired)	60,000	
Total	316,000	

£10 million issue of stock last October, £40,000 has been set aside to provide a reserve against the initial expenses and losses in the development of fishery activities, and a balance of £121,341 remains to be carried forward.

Although earnings have continued to grow, a review of the present situation, and of the prospects for the immediate future years, discloses that the rate of growth of expenditure is rapidly overtaking revenue. The principal contributing factors are the large volume of new capital investment at high interest rates, the continued rise in expenditure on fuel and increases in salaries and wages. A further factor of significance is the abnormally low return on capital in new rural areas. To ensure proper financial stability, steps have been taken to revise tariffs.

The value of plant brought into commission was £11·9 million as compared with nearly £9 million during the preceding year. The total investment in assets in productive use at the end of the year was £71 million, and expenditure of £12·9 million was incurred on new capital works which were still under construction at the end of the year. The total fixed capital investment, therefore, was approximately £84 million. Capital expenditure during the year under the rural electrification scheme amounted to nearly £4 million, and the total investment in the scheme to 31st March last was £16·9 million.

Last year the Board generated 1,570 million kWh as compared with 1,458 million kWh in 1954-55, an increase of 7·6 per cent. The total installed capacity at 31st March last was 512,500 kW, comprising 324,500 kW of steam plant and 188,000 kW of hydro-electric plant. New stations which will increase the generating capacity by 316,000 kW were under construction or planned.

The generating plant programme included two milled-peat-fired stations in Co. Mayo, one at Bellacorick having a capacity of 40,000 kW and the other at Bangor Erris with a capacity of 20,000 kW. Investigation into the effective utilisation of milled peat produced at Bangor Erris bogs disclosed that it would be more economical to transport the milled peat from the Bangor Erris bogs to Bellacorick station than to erect a separate station at Bangor Erris. In the circumstances the Board decided to increase the capacity of Bellacorick by 20,000 kW and to delete the Bangor Erris station from the programme.

During the year 70 miles of 110 kV lines, 64 miles of 38 kV lines and 60 miles of 10 kV lines (excluding rural lines) were erected. Preliminary investigations were made on the design of a 220 kV line from Rhode station to Finglas transformer station at Dublin.

Rural Electrification

Areas completed to date under the rural electrification scheme number 463 out of a total of 797 to be developed. During the year 6,196 miles of rural transmission lines were erected and, with 99 areas completed, the Board practically achieved its target (100 areas). At the present rate of progress it is expected that all areas will be supplied within $3\frac{1}{2}$ years. The 463 areas completed cover 12,325 square miles, or an average of 26·6 square miles per area. A further 70 areas are under construction or selected for development, making a total of 533 areas, or 14,512 square miles. Supply is now available to 65 per cent of the population and the proportion of dwellings connected in the completed areas is approximately 74·6 per cent. While rural consumption has continued to increase, being 208 million kWh as against 166 million in 1954-55, the average per consumer, at 1,332 kWh, has not altered appreciably. The limited use of electricity by new consumers, the Board says, tends to offset the greater consumption of those connected in the earlier years.

Increased use was made of the farm electrification advisory service provided by the Board. In the past year sales of equipment in the rural areas by the Board were 33 per cent higher than in the previous year.

A report on the revised proposals embodying a pumped storage project for the hydro-electric development of the Torc Waterfall, Co. Kerry, was being studied and the economics of a development on the Ballisodare River, Co. Sligo, were under review. There are no immediate plans to make use of nuclear energy for electricity generation but the Board says it is continually in touch with developments in this field.

PERFORMANCE OF GENERATING PLANT IN 1955-56

HYDRO-ELECTRIC STATIONS

Station	River	Installed capacity kW	kWh sent out Millions	Plant load factor %	Cost of generation per kWh sent out	
					Works cost d.	Total cost d.
Ardnacrusha	Shannon	85,000	251·260	34·1	0·115	0·363
Cliff	Erne	20,000	54·224	31·3	0·092	0·464
Cathaleen's Fall	Erne	45,000	145·355	37·3		
Pollaphuca	Liffey	30,000	14·429	5·7	0·340	1·173
Golden Falls	Liffey	4,000	5·743	16·7		
Leixlip	Liffey	4,000	8·959	26·1		

STEAM STATIONS

Station	Installed capacity kW	kWh sent out, millions	Plant load factor %	Fuel type	Fuel cost per ton £ s. d.	Fuel cost per kWh sent out d.	Cost of generation per kWh sent out	
							Works cost d.	Total cost d.
Portarlington, Co. Laoise	25,000	128·111	62·1	Sod peat	2 10 0	0·761	0·913	1·120
Allenwood, Co. Kildare	40,000	209·722	63·7	Sod peat	3 0 10	0·908	1·021	1·227
Pigeon House, Dublin	95,000	86·080	11·4	Coal	4 13 11	1·014	1·612	2·056
North Wall, Dublin	44,500	161·732	44·5	Oil	6 9 9	0·599	0·729	0·960
Ringsend, Dublin	60,000	132·428	44·8	Oil	6 10 5	0·515	0·558	1·005*
Marina, Cork	60,000	300·035	59·6	Coal Oil	4 14 10 6 10 0	0·504	0·565	0·771

* In commission for part of year only.

INDUSTRY AND THE HOUSE

Safety in Factories : Health Aspects of Radiation

By A. M. F. PALMER, A.M.I.E.E., M.P.

THE work of the House of Commons moves on steadily, but Members feel an ever-increasing sense of monotony and routine; like travellers through a tunnel they see ahead of them with relief the light which marks the summer recess. True, of course, when the House adjourns (on 2nd August) there will be the usual protests that the country is to be left so long without a Parliament sitting, but who can honestly deny that the quality of parliamentary discussion is enhanced because we do not talk all the time?

Now the Finance Bill has left us there is time for other matters. Incidentally, something in the end will have to be done to change the situation in the Commons created each year by the Committee stage of the Finance Bill with its long drawn out debates which effectively block anything else at all coming before the House. I know there are theoretical constitutional dangers in a change, but is it really impossible for the detailed work of the Finance Bill to be handled by a specially constituted Standing Committee?

Industrial Safety

A recent interesting small debate was when the Opposition raised on the Ministry of Labour vote the matter of industrial safety. Mr. Fred Lee, the Labour Member for Newton, of the Amalgamated Engineering Union said that the time had come when the country should obtain a better perspective in industrial questions. For instance, the report of the Industrial Safety Sub-Committee of the National Joint Advisory Council had stated that injuries to workers cost the country 20 million days a year; 700 workers were killed and 180,000 injured by factory accidents. In addition there were some 60,000 absent from work each day for the same cause. All this showed that nobody was taking enough interest in a very human and unfortunate aspect of industrial life. Mr. Lee put the blame on the smallness of the Factory Inspectorate. He said the full establishment of the Department was 380, but the number available for duty was only 314. That depleted force had to deal with 340,000 "work-places" under the Factories Acts. In 1954 they had achieved only about 50 per cent of possible visits to factories and he was alarmed to note that the visits were even diminishing. The Minister of Labour should really consider making a large increase in the Inspectorate. To double the force would be by no means too much; also at least half of the inspectors should have technical qualifications.

Answering these points, Mr. Robert Carr, Parliamentary Secretary to the Ministry of Labour, who has a background of personal works experience, said the Minister believed the time had come when a new impetus could and should be given to the work of the Factory Inspectorate. He agreed it was a matter for concern that since 1952 the downward trend in the number of reported accidents had ceased, although allowances should be made for the greater number of people at work. The building industry had a particularly high accident rate; the number had risen from just over 12,000 in 1950 to nearly 14,000 in 1954.

In an obvious reference to the Keighley mill disaster, the Parliamentary Secretary said that already special action had been taken to reduce fire risk in factories. The Chief Inspector had written to factory occupiers reminding them of their obligations to have effective fire alarms, and had sent them a guide about installation. A national survey had been started, which should be completed by the end of October. Mr. Carr argued that joint safety committees were the best way to express successfully the determination to do something about accident prevention.

The House then moved to a discussion on risks in nuclear energy when Mr. Turton, the Minister of Health, moved that the House note the report on nuclear and allied radiations contained in Command Paper No. 9780. For the Opposition Dr. Edith Summerskill drew attention to the statements made at the British Medical Association at Brighton when Sir Ernest Rock Carling had said that the uses for radioactive sources in industry steadily grew, which meant more and more people were being brought within their range. Geneticists feared deterioration of the average intelligence (alarming thought!) and an increase of mental disorder. She thought that the Minister was extremely complacent about the whole question. He was not paying anything like enough attention to the serious conclusions of medical and scientific experts.

Although much of the discussion then turned to dangers from nuclear bomb tests, a Conservative Member referred again to the industrial aspect. This was Mr. Charles Orr-Ewing, who sits for Hendon North. He urged that some industrial processes should be looked into afresh; it was only recently that there had been revealed the amount of radiation to which workpeople were exposed through ordinary occupations such as X-ray fitting for shoes and luminous paint processes. He wanted a committee to look into the industrial health aspect of radiation.

However, Mr. Turton still thought the findings in the White Paper reassuring. They did not, he contended, reveal any present danger from the peaceful use of radiation. He agreed, however, that we were entering a new period when it was possible that in the end nuclear energy would be the principal source of power and it was necessary to have an understanding of the extent of the dangers that might accompany such change. Firms using radioactive isotopes were specially visited by the Factory Inspectorate and in 1947 regulations had been made to protect workers in factories where luminous paints were in use. More general regulations were in draft and being discussed with the experts. He thought these might be published early next year.

Select Committee on Nationalised Industries

Recently the Government, with a great optimism, allocated a day to two important discussions. It was intended to dispose of the Coal Industry Bill, which grants increased borrowing powers to the National Coal Board, by 7 o'clock and afterwards move to the motion for the setting up of the new Select Committee on Nationalised Industries. However, things did not go according to plan, to the obvious annoyance of Ministers. Mr. Butler the Lord Privy Seal, who was to move, walked in a little before 7 o'clock to find the coal battle still merrily continuing with three main forces engaged. First, the thin line of the Minister of Fuel and Power, Mr. Aubrey Jones,

and those behind him; then the official Opposition, clearly in very good form, and below the gangway on the Conservative side a well-led pirate crew of coal critics under Mr. Nabarro, on this occasion more buccaneer-like than ever. He seemed bent on keel-hauling his admiral. Mr. Butler withdrew, returned an hour later to find hostilities still not over and finally had to postpone the debate on the Select Committee to another time.

Naturally, the Opposition—with some justice—put the blame on Government supporters for the muddle that occurred, saying primly that *they* were anxious to co-operate in giving the Coal Board the money it must have to modernise the industry, and that it was the Tory rebels who had talked out the time. Behind the scenes the Government probably took the same view. In some quarters it is said that Ministers are now almost neutral in the matter of the Select Committee, and since the Conservative back benchers most insistent on the Committee were loudest in attacking the Coal Board, then these must await the Government's pleasure before the Select Committee business is brought forward again.

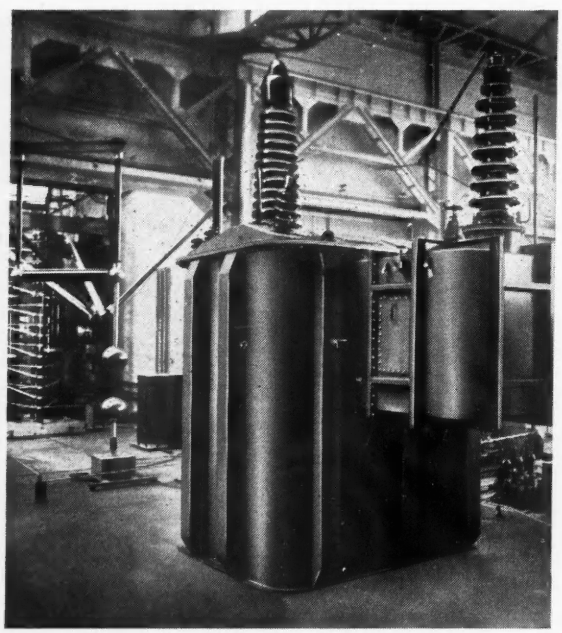
If the truth be told, the Opposition also are not too united over the Select Committee, so maybe the way things turned out suited everybody except Mr. Butler.

Supergrid Transformers

Impulse Tests at Edinburgh Works

GREAT progress has been made in recent years in the collection of data on the effects of lightning on transmission systems, and high-voltage research and study of insulation strength problems on the transformers used in conjunction with these systems have reached a point where the largest power units can now be built to withstand the severe conditions.

Bruce Peebles & Co., Ltd., have played a leading part in these developments and recently a large party of prominent electrical engineers visited their works at Edinburgh to witness impulse tests on a full-scale prototype of one phase of a 120 MVA 275/132 kV three-phase auto-connected transformer, four of which—all with on-load tap changing switchgear on the 132 kV terminals—are on order for the South of Scotland Electricity Board for Clyde's Mill substation. They are for connection to the Scottish end of the 275 kV supergrid now under construction to provide greater capacity of interconnection with the 132 kV grid, so that the policy of national pooling of generating resources may be extended.



Set-up for impulse tests on supergrid transformers

The specified impulse level of 1,050 kV did not present difficulties in demonstration since ample high-voltage testing plant is available, and the tests were successfully carried through without a hitch. In the accompanying illustration the prototype transformer is seen in the foreground and behind it the sphere gap and the 1,875 kV impulse generator. The type tests comprised the application of full wave impulses at 525, 790, and 1,050 kV, followed by two chopped wave impulses at 1,210 kV and, in turn, by two further full wave shots at 1,050 kV. The level and the sequence of tests was that recognised as the appropriate British Standard and the waveshape throughout was the standard 1×50 microsecond.

Having withstood these tests successfully it was decided to submit the prototype transformer to a series of successively higher voltage tests until possibly eventual breakdown, and it is of interest to record that the 275 kV winding was subjected to more than seventy impulses ranging uniformly from 1,050 kV full wave up to 1,660 kV chopped wave without breakdown or any signs of serious weakness.

These tests, apart altogether from showing that the design of the transformers provided an adequate safety margin for any conditions they are likely to meet in service on the 275 kV supergrid, proved conclusively that the arrangement of disc-type high-voltage winding used on the prototype, a construction which is recognised as the strongest mechanically, will be entirely suitable for use on transformers for systems operating at 330 kV and 380 kV. Several countries overseas are already using these higher voltages, so that knowledge gained on the prototype transformer has been an invaluable aid to the company's endeavours to secure orders in a developing export market.

Courses in Higher Technology

THE London and Home Counties Regional Advisory Council for Higher Technological Education have just published their bulletin of special courses in higher technology, including management studies and commerce, covering the autumn term 1956. This summarises all the special advanced courses held in the London and home counties region and not regularly appearing in college calendars or prospectuses. Part I of the bulletin, which is that covering the autumn term, can be obtained from the Council at Tavistock House South, Tavistock Square, London, W.C.1, price 1s 6d, post free. Part II, covering courses to be held in the spring, will be available in December.

OVERSEAS ELECTRICAL TRADE

January–June Exports Show a Considerable Rise

THE June figures of electrical exports were somewhat lower than for the preceding month, falling from £19·4 million to £19 million, but last month included the Whitsun holiday and there were, therefore, fewer working days. It will be seen from Table I that for the first half of this year electrical exports showed an advance of £19 million (from £90·6 million to £109·6 million), although it has to be borne in mind that the 1955 figures were seriously affected by the rail and dock strikes which commenced towards the end of May.

There were small decreases in exports of most classes of electrical goods in June, as compared with the previous month, the exceptions being generating plant and motors, the value of which rose from £2,747,529 to £2,920,864, and radio and television exports which improved from £2,776,255 to £3,138,023.

Canada was again the chief purchaser of generating plant and motors, with a value of £347,432, Australia being second with a total value of £324,156. Outside the Commonwealth, the principal buyer was the United States which took plant valued at £211,057. Exports of converting machinery, mercury-arc rectifiers, transformers, switchgear, etc., were valued at £2,514,737, as compared with £2,532,017 in May, India maintaining its place as the

TABLE I.—ELECTRICAL EXPORTS

Class	June, 1956	Six months ended June, 1955	Six months ended June, 1956
	£	£	£
Generating sets and generators:			
Diesel-driven, up to 10 kW	167,938	694,475	834,259
Ditto, 10 to 65 kW	139,788	849,793	747,847
Ditto, 65 to 200 kW	174,396	589,043	924,602
Ditto, over 200 kW	402,688	2,627,077	1,784,216
Spark ignition engine driven	15,932	123,301	214,749
Steam turbine driven	199,042	846,322	354,075
Hydraulic turbine driven	—	172,417	51,786
Other prime mover driven	112,177	160,031	435,639
Generators, not exceeding 200 kW	128,576	741,280	766,792
Ditto, over 200 kW	63,695	633,650	497,571
Parts of generators	459,641	2,721,256	3,427,304
Motors, complete, other than railway, tramway and trolley-bus:			
Up to ½ h.p.	193,930	1,232,039	1,245,760
Over ½ but under 1 h.p.	56,907	365,367	363,261
1 h.p. to 250 h.p.	367,873	2,159,271	2,532,099
Over 250 h.p.	97,355	423,352	447,414
Railway, tramway and trolley-bus motors complete and parts of all motors	149,228	811,127	999,197
Motor starting and controlling gear	191,698	1,153,804	1,399,774
	2,920,864	16,303,605	17,026,345
Converting machinery	64,622	254,132	218,461
Mercury-arc rectifiers	93,626	368,183	408,432
Transformers for lighting, heating and power (incl. coils)	872,430	5,230,541	6,430,671
Switchgear and switchboards (not telegraph or telephone), up to 200 A and 660 V	321,963	1,607,717	1,644,816
Ditto, other	1,162,096	5,905,760	7,032,236
	2,514,737	13,366,333	15,734,616
Primary batteries:			
Lighting	77,250	415,725	481,463
Radio	251,269	1,010,371	1,456,211
Other	42,635	225,708	261,684
Parts (excl. carbons)	39,751	181,359	232,874
Lamps:			
Filament, exceeding 24 V	97,383	524,165	602,605
Ditto, under 24 V	26,863	184,309	173,881
Arc lamps and searchlights	25,628	71,137	124,999
Discharge lamps, fluorescent tubes, etc.	69,061	406,726	413,922
Radio and television, etc., apparatus:			
Thyratrons, hot cathode mercury vapour and gas-filled rectifiers (excl. mercury arc rectifiers), photo-electric cells, stabilising and cold cathode valves, magnetrons, klystrons	29,947	136,524	166,988
Cathode-ray tubes	25,062	66,559	130,306
Other valves (not X-ray)	264,834	1,044,657	1,186,743
Parts (excluding glass bulbs)	4,966	134,936	68,045
Radio and television transmitters	172,792	382,914	475,072
Commercial radio and radar equipment	1,462,099	5,939,401	7,402,955
Domestic radio receivers, mains	121,673	962,930	858,927
Ditto, battery	79,691	397,237	479,255
Ditto, other (incl. car)	29,955	132,980	153,537
Radiograms	31,424	283,401	222,811
Television sets	17,831	53,773	245,193
Public address equipment	82,972	479,594	543,169
Sound reproducing app., n.e.s.	29,159	130,669	193,786
Components and parts, n.e.s.	785,618	3,355,412	4,050,354
	3,138,023	13,500,987	16,177,141
Telegraph and telephone installations	566,577	3,891,088	3,775,971
Telephone instruments, separately consigned	116,749	483,092	730,443
Telegraph and telephone parts	709,591	2,816,179	3,610,546
Line apparatus for long distance commun.	235,577	469,159	1,054,056
	1,628,494	7,659,518	9,171,016

Class	June, 1956	Six months ended June, 1955	Six months ended June, 1956
	£	£	£
Cookers	90,437	772,054	510,898
Toasters	21,503	192,541	129,150
Other cooking apparatus	42,122	173,076	220,937
Parts and accessories	81,112	399,715	514,246
Space heating appliances	20,946	240,393	250,629
Water heating appliances	33,955	177,750	205,400
Other heating appliances	37,533	171,746	243,556
Parts and accessories	71,742	395,775	387,115
Irons	97,844	625,059	618,333
Arc welding equipment, a.c.	56,338	184,887	332,833
Ditto, d.c.	58,710	169,881	292,218
Resistance welding equipment	15,228	116,962	120,665
Electric furnace plant	42,324	222,674	330,125
Magnetos, ignition	56,292	98,113	190,280
Sparking plugs	191,702	916,108	980,006
Elec. appliances for aeroplanes, n.e.s.	221,057	1,133,548	1,240,986
Ditto, for motor vehicles, n.e.s.	378,140	1,788,908	2,169,189
Ditto, for cycles, n.e.s.	48,955	423,648	424,895
Signalling app. (incl. traffic signals)	70,207	285,699	379,079
Industrial radio-frequency equipment	10,813	86,851	59,640
Bell app. (not telegraphic or telephonic)	6,990	51,845	55,515
Instruments, commercial	181,133	824,787	1,075,354
House service meters (including parts)	151,326	707,580	1,042,230
Electro-medical apparatus (not X-ray)	45,562	263,471	354,448
X-ray apparatus (excl. tubes and valves)	68,218	376,254	400,338
Vacuum tubes	26,506	139,037	156,673
Ceiling fans, complete	132,241	523,126	669,298
Desk fans, complete, and parts of desk and ceiling fans	48,367	172,629	210,881
Vacuum cleaners	165,745	792,226	823,643
Floor polishers	54,044	514,147	463,163
Food mixers	63,749	277,338	389,154
Hair clippers and dry shavers	46,375	461,421	412,058
Other portable appliances	32,246	280,951	193,528
Parts	127,621	439,506	720,240
Portable elec. tools (not saws) and parts	200,091	1,083,846	1,235,660
Cables and wires:			
Telegraph and telephone, submarine	87,715	482,943	1,398,600
Ditto, other	774,665	2,915,195	4,990,156
Cotton, silk, or art. silk insulated	56,499	286,907	368,172
Enamel, glass or asbestos insulated	116,293	433,450	572,654
Paper insulated	1,042,867	3,504,831	5,866,911
Rubber insulated	588,752	2,820,836	3,124,561
Thermoplastic insulated	158,234	415,623	841,057
Other	223,774	1,121,067	1,396,429
	3,048,799	11,980,852	18,558,540
Accumulators for motor vehicles	163,712	847,747	1,042,313
Ditto, traction	17,837	90,010	130,115
Ditto, radio and other portable	91,934	361,286	519,690
Ditto, other	180,178	138,689	452,190
Parts and accessories	103,505	494,615	530,418
Elec. porcelain, etc. (incl. insulators)	118,972	525,712	654,425
Insulating cloth and tape	48,641	358,290	351,977
Other insulating material	129,543	541,594	608,983
Permanent magnets	49,603	276,238	277,639
Radio, telegraph and telephone testing equipment, n.e.s.	41,460	256,105	240,975
Scientific elec. instruments (not telegraphic or telephonic):			
Time recorders and time switches, complete	11,330	173,665	75,557
Other	190,718	1,270,334	1,186,136
Electrical machinery, n.e.s.	162,781	524,051	732,904
Electrical apparatus and appliances, n.e.s.	816,091	3,414,637	4,572,495
TOTAL	19,004,236	90,587 320	109,593,477

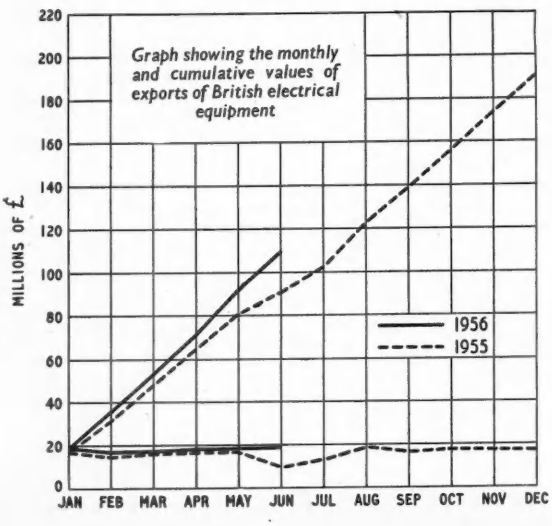
TABLE II.—DISTRIBUTION OF EXPORTS OF ELECTRICAL MACHINERY, APPARATUS AND APPLIANCES

Country	June, 1956	Six months ended June, 1955	Six months ended June, 1956
	£	£	£
Channel Islands	65,714	298,778	449,600
Gibraltar	46,256	126,358	254,755
Malta and Gozo	46,136	286,568	382,559
Cyprus	134,232	567,231	896,079
Sierra Leone	25,977	150,296	150,887
Gold Coast	172,207	755,744	891,361
Nigeria	332,620	1,442,782	1,763,601
Union of South Africa	1,004,653	9,196,123	7,773,243
Rhodesia and Nyasaland	514,850	2,268,766	3,210,854
Tanganyika	31,381	451,217	321,533
Kenya	198,595	892,376	1,367,430
Uganda	91,797	503,446	455,329
Anglo-Egyptian Sudan	67,848	514,845	510,674
Mauritius	17,126	188,104	152,366
Aden	41,895	271,901	310,431
Bahrain, Qatar and Trucial States	86,475	474,227	558,483
Kuwait	135,349	530,169	725,495
India	1,861,793	7,479,551	10,682,798
Pakistan	402,192	1,983,116	1,697,144
Singapore	326,999	1,895,542	1,788,454
Federation of Malaya	282,674	1,352,370	1,613,435
Ceylon	180,163	650,466	950,804
British North Borneo	14,942	132,684	146,872
Sarawak	12,411	116,564	111,266
Hong Kong	238,913	871,080	1,206,830
Australia	1,723,679	9,736,616	10,989,550
New Zealand	767,294	6,310,030	5,421,737
Fiji	15,467	132,610	99,110
Canada	1,177,669	3,275,775	6,491,572
Jamaica	105,414	472,261	685,122
Barbados	19,451	97,753	158,272
Trinidad	110,570	479,074	680,264
British Guiana	34,997	280,516	237,317
Other Commonwealth countries	92,642	635,528	542,042
Irish Republic	346,851	1,895,489	1,826,089
Soviet Union	162,808	1,121,292	1,479,760
Finland	205,759	601,323	893,945
Sweden	414,683	1,963,714	1,913,335
Norway	287,784	1,838,117	1,323,855
Iceland	23,870	62,164	92,582
Denmark	189,167	867,935	1,048,475
Poland	29,397	134,936	176,265
Western Germany	170,597	908,529	1,049,656
Netherlands	750,914	3,232,413	3,672,546
Belgium	332,532	1,345,878	1,702,095
France	305,835	1,550,284	1,895,137
Switzerland	114,898	485,240	597,740
Portugal	127,778	1,378,822	1,056,052
Spain	594,560	853,663	2,009,290
Italy	234,092	1,279,388	1,777,929
Austria	20,219	268,295	222,502
Yugoslavia	47,584	366,644	345,744
Greece	326,122	577,787	1,360,331
Turkey	71,150	567,006	452,141
Belgian Congo	14,384	176,107	173,401
French Morocco	53,278	176,253	269,246
Portuguese East Africa	10,123	110,525	135,754
Egypt	214,053	788,557	1,094,459
Libya	16,736	88,992	123,406
Syria	57,035	176,881	359,061
Lebanon	44,415	195,389	302,832
Israel	153,680	211,911	550,658
Jordan	76,789	169,816	334,410
Saudi Arabia	294,280	456,712	671,848
Iraq	420,912	1,305,692	2,091,910
Iran	218,617	382,529	1,117,976
Burma	89,412	947,842	786,457
Thailand	86,534	844,450	622,458
Indonesia	70,046	144,619	327,238
Japan	98,054	539,383	395,439
United States	882,230	2,220,730	5,105,241
Cuba	49,590	131,353	208,646
Mexico	61,698	175,447	389,209
Colombia	37,313	474,922	491,609
Venezuela	293,090	1,487,398	1,787,995
Peru	82,900	185,607	305,146
Chile	41,755	187,790	168,946
Brazil	173,382	225,013	1,324,254
Uruguay	7,728	228,935	62,073
Argentine Republic	36,763	943,764	400,800
Other foreign countries	282,458	1,491,317	1,420,267
TOTAL	19,004,236	90,587,320	109,593,477

principal customer with purchases valued at £416,876. Other important purchasers were Australia (£334,022) and South Africa (£242,750).

The greatest decrease in exports occurred in the cables and wires group, which fell from the high figure of £3,950,380 in May to £3,048,799. India was the principal market with a value of £568,779. Shipments to Canada, which in May reached the exceptionally high figure of over £1,000,000, fell in June to £106,056. The chief buyer of telegraph and telephone material, exports of which totalled £1,628,494, was Australia, with a total of £214,362. Spain was second, taking £174,125 worth of equipment. Table II gives the usual analysis of exports according to destinations.

In addition to the goods in the electrical division of the Board of Trade returns, the following apparatus appears in other sections and is not included in our tables:—Electric washing machines, not exceeding 150 lb net weight: June, £268,261 (£254,263); half-year, £1,808,985 (£1,616,874). Ditto, 150-250 lb: June, £125,059 (£60,531); half-year £632,173 (£690,150). Parts of electrically-operated washing machines: June, £108,435 (£20,576); half-year, £431,165 (£332,227). Electric light fittings and lanterns, complete, with or without lamps: June, £139,943 (£56,013); half-year, £872,973 (£609,300). Electric locomotives: June, £261,906 (£191,988); half-year, £993,164 (£1,050,605). I.c. engine locomotives with electrical transmission: June, £600,438 (£116,837); half-year, £5,103,964 (£2,225,509).



Imports of electrical equipment, which have declined in recent months, rose from £1,798,207 in May to £2,131,748 last month, and the six months' total was £11,990,599 (against £10,625,373 for January-June, 1955). The United States was again the largest supplier with goods valued at £767,184 (bringing her total for the six months to £3,535,818), the next country in order of importance being Western Germany which supplied goods valued at £303,361. As in the preceding month the principal imports were in the radio and electronic apparatus group, which totalled over £900,000.

B.B.C. North Hessary Tor Station

THE B.B.C.'s v.h.f. sound broadcasting station at North Hessary Tor, South Devon, will be brought into service on 7th August and will transmit the West of England Home Service on 92·5 Mc/s, the Light Programme on 88·1 Mc/s, and the Third Programme on 90·3 Mc/s, each with an effective radiated power of 60 kW. This new station is on the same site as the B.B.C.'s North Hessary Tor television station.

LETTERS TO THE EDITOR

Letters should bear the writers' names and addresses, not necessarily for publication. Responsibility cannot be accepted for the opinions expressed by correspondents

Competition or Integration ?

I AM afraid "Reflector" (*Electrical Review*, 13th July) places far too much reliance upon competition between the nationalised fuel industries. There are many anomalies caused by financial competition. For instance, the Coal Board are reluctant to spend their restricted capital to make coke and sell gas though there are many instances where this is desirable.

On the other hand, the steel industry must have coke for ironmaking and thereby produces large volumes of coke oven and blast furnace gas which, since they cannot sell at an economic price and the Gas Boards cannot buy at a competitive price, is burnt in boilers and used to produce electricity in small power stations. These stations cannot operate at the efficiency of modern power plants and the Electricity Board cannot afford to purchase the power at a price higher than that at which they could generate for themselves.

Each organisation must show a profit on the transaction or refuses to take part and thereby competition has justified itself. The only sufferer is the nation—by excessive capital expenditure and inefficiently used fuel, the life blood of our country. If this can happen at generation level, what must be happening on the distribution side? Is it not possible that instead of duplicating coal, gas, oil and electricity services to every street in the kingdom that, by rationalisation, charges could be reduced out of all proportion to the savings of unhealthy competition? Give me a lot more integration.

Bexleyheath, Kent. F. L. WARING, A.M.I.E.E.

Log-Log Scales and Interest Rates

I WAS interested to read the article on "Log-log Scales and Interest Rates," by Mr. O. M. Meares, in your 13th July issue, p. 59.

A similar method was published in the *Students' Quarterly Journal* of the I.E.E. a year or two ago. This was based on the approximation

$$\log_e (1+r) \simeq \frac{r}{\sqrt{1+r}}$$

which holds to a higher value of r than that given in Mr. Meares' article.

The method of setting the slide rule is as follows:

(a) Set the cursor to r on the D scale.

(b) Bring (1+r) on the B scale to the cursor.

The rule is then set for reading off powers of (1+r) on the log-log scales.

Nottingham. R. D. KENDON.

Earth Fault Protection

AS ALWAYS, I have read Mr. Swann's article, "Earth Fault Protection" (*Electrical Review*, 13th July), with great interest, and his points are, of course, important and irrefutable.

May I add one other common case in which the loop test may prove misleading, or dangerous, to those mentioned by Mr. Swann, and this is in houses where gas water heaters are in use—probably a very large number. The metallic interconnection of the gas and water services brings the resistance of the former into parallel with that of the water service, and as has been shown in recent investigations, the usually lower resistance of the gas service means that it may become the more important member of the earthing system. In any case, the shunting of the water service cannot fail to give a misleading result, where it is used as an electrode.

Elham, Kent. T. C. GILBERT.

Does Domestic Electrification Pay ?

THE letter from the Coal Utilisation Council in your issue of 20th July is perhaps only to be expected from a competing domestic service. Reference to "useful therms" comes back to my article in which I refer to the effective efficiency at the point of application as the final criterion —but it is pointless to repeat the article here.

Bexley. E. H. W. BANNER.

FUEL RESEARCH BOARD

Annual Report for 1955

IN the report of the Fuel Research Board for 1955 (69 pages, H.M. Stationery Office, Kingsway, London, W.C.2, 4s) the Director, Dr. A. Parker, refers to the many new problems needing solution if the recent improvement in boiler availability is to be maintained. The proportion of troublesome fuels is rising, while pressures and final steam temperatures are increasing. In addition more fuel oils, containing relatively large amounts of sulphur, are being used in power stations, heightening the tendency towards corrosion and fouling of low-temperature surfaces by sulphuric acid produced from sulphur trioxide formed during combustion. Formation of this trioxide can be reduced by using a low-sulphur fuel and also a low "soft" flame temperature (less than 1,500 deg. C.) and very little excess air—conditions not usually conducive to good combustion. Fouling of high-temperature surfaces is less serious than formerly, but many deposits are bonded by salts of alkali metals. The results are given of studies of the distribution of decomposed and volatilised compounds of sodium and potassium throughout the boiler system in relation to their harmful effects. A method of simultaneous determination of sulphur and chlorine in coal is described. The weight of grit (particles larger than 76 microns) passing to chimneys can now be ascertained within the accuracy prescribed by the British Standards Institution.

The Fuel Research Station has provided fundamental data required for the design of a pilot plant to treat 2 million cu ft of gas per hour for the removal of oxides of sulphur from flue gas.

This plant is to be erected at a power station by Simon-Carves for the Central Electricity Authority. In this process sulphur is recovered as ammonium sulphate and elemental sulphur. Earlier experiments had shown two or more stages to be necessary for removal of more than 95 per cent of the sulphur with only a small loss of ammonia. By means of a ring-ball mill, now in operation at a power station, a best "performance coefficient" obtainable with any given coal can be expressed as the maximum weight of fines passing a 200 mesh B.S. test sieve than can be produced with unit power consumption.

Numerous other research activities having an electrical bearing mentioned in the report range from the extraction of germanium from flue gas to the development of a slagging cyclone combustion system and a gas-cleaning equipment for open-cycle gas turbines.

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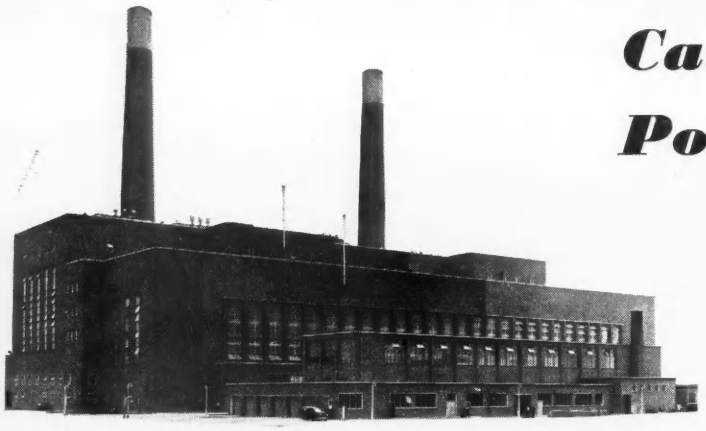


Carrington Power Station

OPENING OF NEW STATION ON THE MANCHESTER SHIP CANAL

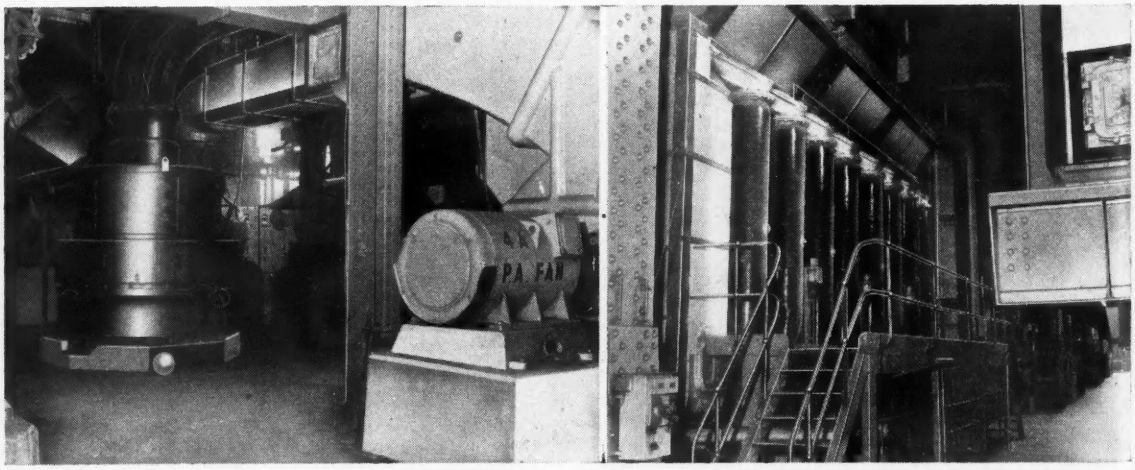
LAST week Carrington power station, in the North West, Merseyside and North Wales Division of the Central Electricity Authority, was formally opened by Alderman Sir William Walker, a past-chairman of Manchester Corporation Electricity Committee and a member of the British Electricity Authority from 1947 to 1952. The site was originally acquired in 1916 by Manchester Corporation but the project was not actually started until 1947, being taken over by the British Electricity Authority on nationalisation.

The site, as can be seen from the plan, is bounded by the Manchester Ship Canal and the River Mersey. The strata appeared on investigation to be of a very variable nature and all major works were piled, approximately 7,850 piles of the reinforced concrete cast in-situ type being used.

Coal supplies for the station come largely by rail, sidings on the main railway line being shared jointly by the C.E.A. and Petrochemicals with an additional bank of sidings exclusive to the Authority. A large coal storage area is available with a capacity of over 200,000 tons. Discharge from railway trucks is by side tipplers, distribution and recovery on the coal store being entirely by bulldozers. Recovery is into a reclamation hopper at the end of the main conveyor. Coal feeds to the station along a single 400-ton/hr conveyor with a space alongside for the future provision of a second conveyor when the "B" station is built on the projected site (see plan); this conveyor will pass over the top of the existing station. Seven bunkers in the power station, one for each boiler, are fed from the main conveyor, and each has a capacity of about 1,000 tons.

Of the seven boilers, the first four were built by Babcock & Wilcox, Ltd., and the remainder by John Brown Land Boilers, Ltd., these being the first designed and erected by this company to be commissioned for the Central Electricity Authority. All the boilers are of the high-head, natural circulation, radiant heat type with pulverised fuel firing and are capable of generating 360,000 lb steam per hour under operating conditions of 940 lb/sq in and 920 deg F. All the boilers are of the single drum type with the pressure parts slung from the building roof steelwork. All expansion is downwards from drum level. Superheaters are of the multi-loop type and tubular attemperators placed between the primary and secondary superheater sections provide means of regulating the steam outlet temperature. Automatic boiler control equipment regulates the supply of fuel, steam pressure, air for combustion, and furnace pressure.

Four Babcock & Wilcox pulverisers supply coal to each of the boilers. These are of the pressurised type as distinct from the more usual suction type and are somewhat less prone to blow-backs. In operation, coal is ground by 14 steel balls, one of which can be seen standing in front of a mill in the illustration below (left). Each mill feeds

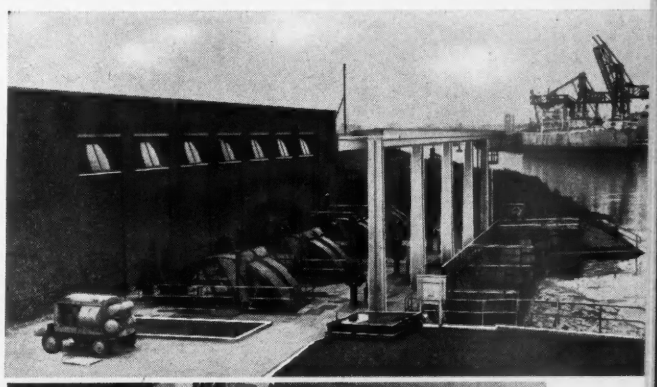


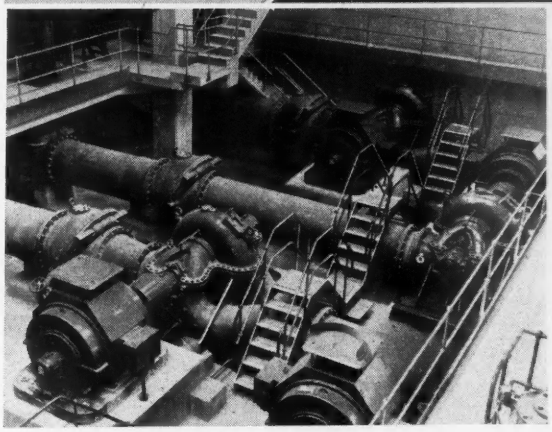
Left: Babcock & Wilcox pulverising mill: in front is one of the 14 steel balls. Right: The burner side of one of the boilers

two triple-port horizontal inter-tube burners, and three mills are necessary for complete full-load operation of the boiler. All these burners are arranged in line on one side of the boiler, and in addition there are four automatic retractable oil burners with electric ignition and pressure atomisation for lighting up. Boiler gross efficiency at e.c.r. is about 88 per cent.

Each of the Babcock & Wilcox boilers has 15 soot blowers, nine of the retractable single-nozzle type operated hydraulically, and six of the mass element type. The i.d. fans have a maximum continuous capacity of 80,000 cu ft/min at 260 deg F and the f.d. fans a capacity of 49,700 cu ft/min. Primary air fans are rated at 15,000 cu ft/min, all three types of fan being made by James Howden. Motors for the i.d. and f.d. fans were supplied by Laurence, Scott & Electromotors, Ltd.

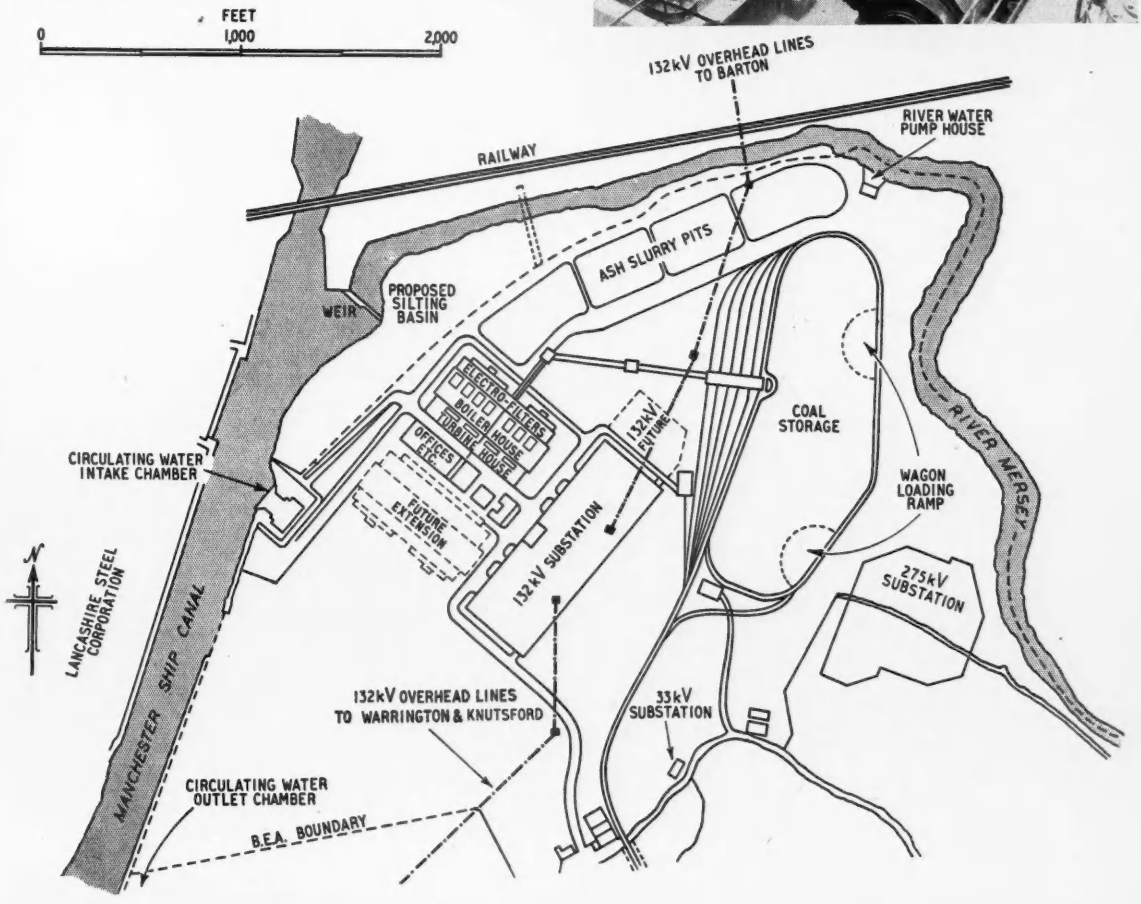
Boiler feed water is supplied by electrically driven and turbine-driven pumps. All have a capacity of 600,000 lb/hr, the driving h.p. being 1,350. Three Mather & Platt electrically driven pumps running at 3,000 r.p.m. and one Weir turbo-feed pump are provided for each pair of sets, the Weir pump being arranged for automatic starting on loss of water pressure in the mains. There is one live steam evaporator per set with a capacity of 25,000 lb/hr, and each pair of sets has a Permutit base exchange water treatment plant with a maximum output of 12,600 gal/hr. Two-stage Lodge Cottrell horizontal

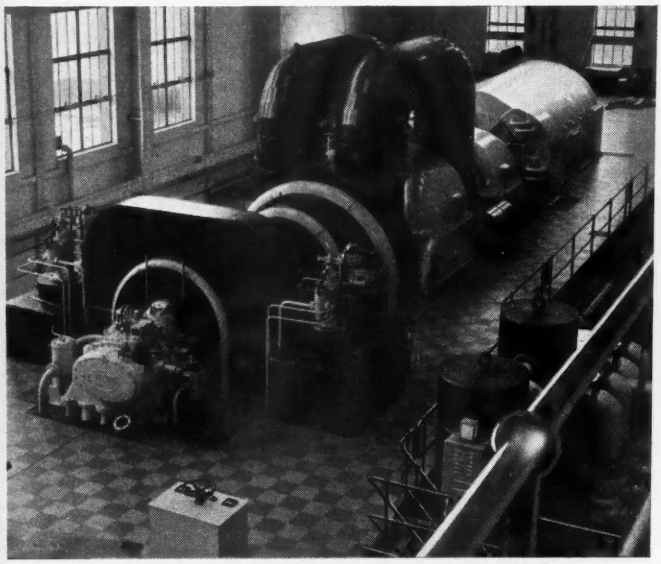




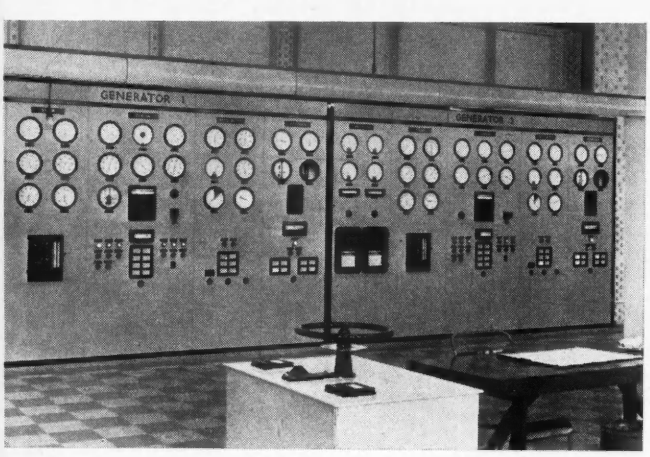
Right: Outside and inside views of the c.w. pump house which draws water from the Manchester Ship Canal

Below: Plan of the power station in relation to the canal and the River Mersey

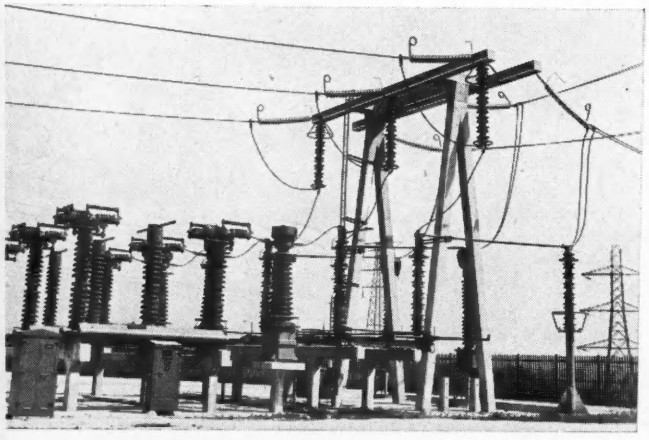




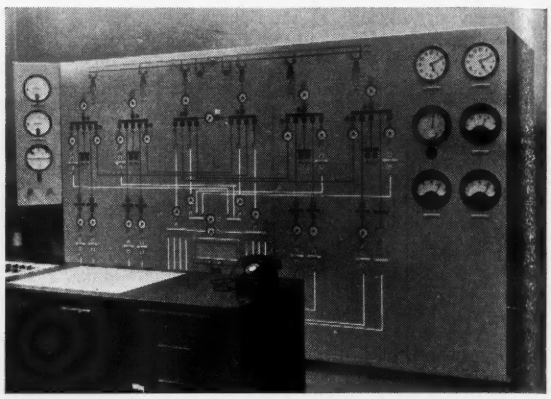
One of the older three-cylinder machines



All the instrument glasses on this turbo-alternator panel are fitted with non-reflecting glass



The clean lines of the Metro-Vick 275 kV circuit-breakers can be seen from this illustration, which shows one installed but not as yet in service on an outgoing line



The station service supplies control panel

flow high-efficiency electrostatic precipitators are provided, two per boiler. The efficiency of these is normally about 98 per cent, but it has been found to drop appreciably to something of the order of 90 per cent when using coals from certain fields in the vicinity. The reason for this difference has not as yet been discovered.

Ash from the boiler furnaces and dust from the precipitators are washed along sluiceways and into an ash sump under the basement floor down the centre line of the station. Here ash is crushed and the slurry pumped along a pipeline to any of the five ash lagoons shown on the plan where the ash is allowed to settle and the water drained off; when full it is dug out and carried away by road to a nearby tip. A small separate water pump housed beside the Mersey supplies water for the ash system.

The "A" station which we are describing contains four hydrogen-cooled 60 MW turbo-alternator sets by Metropolitan-Vickers. The first two are of the three-cylinder type and the second two, of the improved two-cylinder type with three bearings.

A noteworthy advantage of the two-cylinder machines is that each enables a saving of some 14ft to be achieved in the length of the station, an in-line arrangement being employed. The adoption of this design for the second half of the station has thus shortened it by about 28 ft, a well worth while achievement. The turbine speed is 3,000 r.p.m. and the operating conditions are 900 lb/sq in at 900 deg F. Generation is at 11.8 kV.

All the turbines are of the impulse type with the low-pressure section exhausting into two twin blow condensers and two 100 per cent steam operated three-stage air ejectors per set are provided for maintaining condenser vacuum, together with one single-stage quick-start ejector. There are four bled steam heaters, two low and two high pressure, one gland steam heater and a high level full duty de-aerator direct contact heater. The final feed water temperature at full load for Nos. 1 and 2 sets is 300 deg F and for Nos. 3 and 4 sets, 385 deg. F.

The turbo-generator panels for each pair of sets are combined, as can be seen in the accompanying illustration, and a very neat appearance has been achieved. A noteworthy feature is the utilisation of non-reflecting glass in all the instruments. This glass is very slightly cloudy, but this does not matter as it is placed very close to the dial being read. In the case particularly of a panel situated, as these are, directly opposite a great bank of windows, its use enables the operator readily to see the position of his gauges and other instruments from a considerable distance. With ordinary instrument glasses this would prove impossible owing to glare.

The station is equipped with the latest type of Metro-

politan-Vickers turbovisory gear which shows on one recorder the eccentricity and the r.p.m. and on another, the differential expansion of the rotor, the load, the total turbine expansion, the differential temperature and the total steam temperature. Such comprehensive information readily available to the operators gives a much clearer insight into the set condition at any instant and the records are extremely valuable should any trouble develop.

The condensers are of the twin annular flow type with two passes and a cooling surface of 60,000 sq ft. Cooling water requirements are 3 million gal/hr at full load.

Cooling water is taken from the Manchester Ship Canal at a separate intake pump house. Water is drawn in through rough bar-type screens and then through four rotary drum-type fine screens feeding to suction ducts, each of which feeds two Mather & Platt 30/36in "Lonovane" pumps with a capacity of 26,100 gal/min at 48¾ft head. In the pumphouse there are eight pumps feeding through two 78ft diameter steel pipelines to the station and capable of supplying the 13 million gal/hr required. The c.w. pumps operate at 600 r.p.m. and are driven by 460 h.p. motors.

After traversing the condensers the cooling water returns by gravity via two reinforced concrete ducts to the Ship Canal over a side discharge weir and, in order to avoid heating the intake water, this outfall is about half a mile down the Canal from the intake.

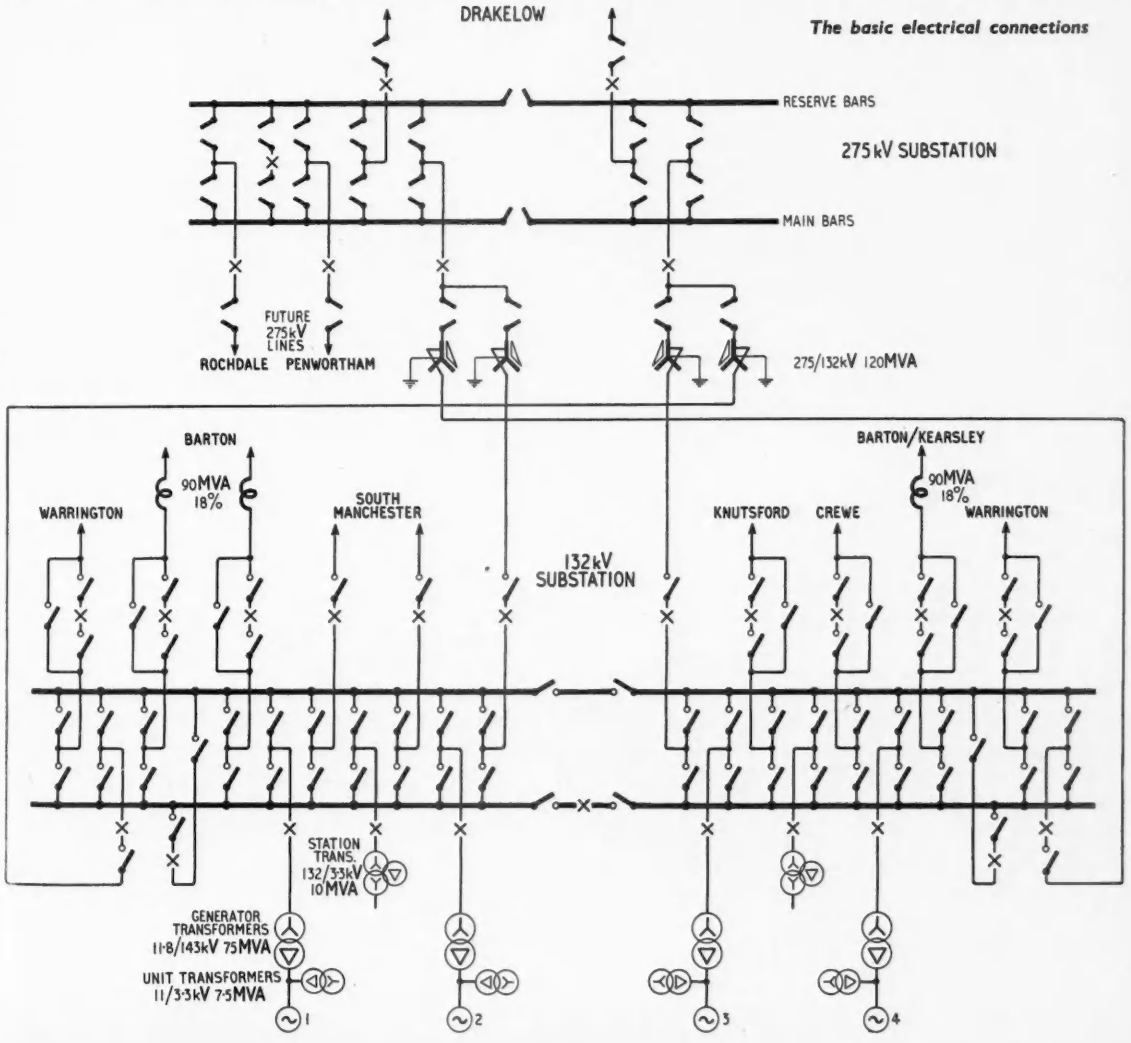
Each turbo-alternator and boiler operates on the unit principle, deriving the normal running supplies from unit transformers of 7½ MVA directly connected to the main alternators. These provide 3.3 kV supplies to English Electric unit switchgear with a fault capacity of 159 MVA. Two station transformers of 10 MVA feed from the 132 kV substation on to other 3.3 kV boards. All this auxiliary switchgear can be controlled from a small auxiliary control and recorder room which we have illustrated and which can be occupied by the shift charge engineer if required. The generators connect to the 132 kV system through 75 MVA 11.8/132 kV generator transformers situated in the 132 kV switchgear compound. These are of the forced-oil, air-cooled type and have on-load tap changing equipment.

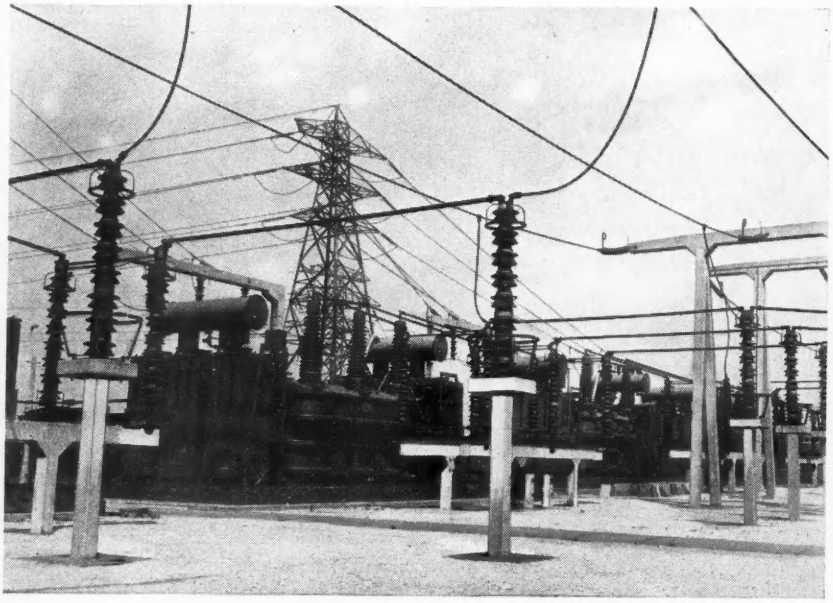
An underground cable tunnel connects the station to the 132 kV substation and conveys all main and multi-core cables. A considerable amount of aluminium sheathed v.i.r. control cables and mineral insulated copper sheathed cables have been used.

Lighting throughout the station is generally by tungsten fittings, but mercury vapour discharge lamps are used in the turbine house and for road lighting.

The station control room is situated in the 132 kV sub-

The basic electrical connections





The 275 kV transformer bank in the switching station

station and includes panels for both the 132 and 275 kV switchgear. The 132 kV control panels are arranged in a horseshoe round the control engineer's desk and the four generator desks are in a line in front of the corresponding generator control panels. Behind the engineer's desk there is provision for a line of panels for 275 kV substation control but at present this substation is controlled by temporary panels on the north side of the control room. In addition to providing all necessary facilities for control indication and alarm of the first two 275 kV lines and the first four transformers, the panels include one for alarms arising from failures of common auxiliaries on the 275 kV substation. Control of the 275 kV gear is by a 50 V d.c. direct wire system over telephone-type multi-core cables. A relay system adjacent to the control room contains protective gear for the 132 kV substation, the relay gear for the 275 kV switches and transformers being located at that substation.

The 132 kV substation was established in 1953 as an outlet for the generating station and as a focal point for four existing overhead lines, to which were added two more, giving bulk supplies to the North Western Electricity Board for the south of Manchester. It is a double busbar station with 22 Metropolitan-Vickers Type GA6S 600 A 3,500 MVA air-blast circuit-breakers controlling nine lines, four generator transformers, two station transformers, four 275 kV transformers connecting to the supergrid, a bus section and two bus couplers. The normal working air pressure of the breakers is 325 lb/sq in and the storage capacity of the air receiver associated with each is 1,220 cu ft of air at normal temperature and pressure. The control supply is 110 V d.c. The self-contained air storage is sufficient for two complete operating cycles.

The 275 kV substation is about a quarter of a mile from the other, being connected by 132 kV overhead lines. Its initial installation provides for a double busbar station with seven air-blast breakers controlling four overhead line circuits and four 275/132 kV transformers. The station will be the main point of interconnection between the 275 kV supergrid and the heavily loaded Manchester areas. At present only two of the overhead lines, those from Drakelow, are being commissioned and two only of the circuit-breakers, those controlling the four 275/132 kV auto-transformers which are banked in pairs on the h.v. side, each pair being fed directly from one of the lines.

The 275 kV switchgear is of the air-blast type with enough air storage for two closing and opening operations in the event of a main air supply fault. Those installed are Metropolitan-Vickers Type GA10W8 with eight circuit interruptions in series per phase. The rated current is 1,200 A and the fault capacity 7,500 MVA. All the isolators in the substation are motor operated because of their physical size, and those which may require immediate operation in case of emergency are capable of remote operation from the control room. The isolators, which are made by the English Electric Co., operate under oil pressure supplied by a motor driven pump running on 110 V d.c. from the substation battery. Their rated current is 1,200 A and electrical bolt interlocks ensure against inadvertent operation.

The four 275/132 kV transformers are also made by Metropolitan-Vickers and have a maximum continuous rating of 120 MVA. They are wound as star/star auto-transformers with a tertiary delta winding and have forced cooling by two radiator banks with oil pumps and six cooling fans. On-load tap changing is remotely operated from the control room, the tap changing mechanism being in separate compartments under the 132 kV terminal bushings. These transformers have a rating of 60 MVA with natural cooling. Protective gear for the lines and transformers is housed in a relay room on the site, the 275 kV lines all having "Contraphase" electronic phase comparison unit type production.

Boiler Availability

AN account of the work of the Boiler Availability Committee (8, Waterloo Place, London, S.W.1) since 1947 has been issued as Bulletin No. MC/277. The present document, by Dr. H. E. Crossley, continues the report of previous investigations which was presented by the same author to the Fuel Economy Conference of the World Power Conference held in that year at The Hague and is a reprint (by permission of the Austrian National Committee) of a paper presented at the fifth plenary W.P.C. held in Vienna in June last. A brief review of the earlier paper is followed by an account of investigations to correlate the external fouling of boilers with the chlorine content of the coals burnt. The reduction of sulphur trioxide in flue gases by carbon or by its adsorption on smokes of carbon or zinc is then discussed.

Among other subjects dealt with are developments in techniques of flue gas testing, such as the use of dewpoint meters and cooled steel probes, and in methods of analysing boiler deposits. The most important means of alleviating fouling or corrosion troubles are given as efficient cleaning on and off load, recirculation of flue gas to the combustion chamber, burning pulverised coal above fuel beds on mechanical stokers and humidification of combustion air. Similar problems, including the effects of using oil fuel, that are likely to arise in future are also considered.

B.T.H. Summer School

COURSE IN ADVANCED ELECTRICAL ENGINEERING TECHNIQUES

LAST week, a summer school in advanced electrical engineering theory and practice was held by the British Thomson-Houston Co., Ltd., at Rugby, mainly for the benefit of senior members of the electrical teaching staffs of the universities and technical colleges although other leading figures in the field of scientific education together with representatives of the technical Press were also in attendance. This was the third summer school to be held by the company since the war and it was arranged to follow very much the same pattern as the last, held in 1952. About twenty engineers and scientists, mainly the younger men of the company, each a specialist in his subject, lectured on the latest developments in electrical engineering research, design and manufacture. Altogether twenty university professors of electrical engineering attended the course together with twenty-one senior lecturers and heads of departments from technical colleges. The whole course was most successful and set an extremely high standard for this kind of event. As a token of the effort which had been put into the course by B.T.H. staff, the professors and lecturers presented the company with a cheque with which to purchase the coats of arms of the British universities to decorate the entrance hall of the new education building which is shortly to be erected alongside the main offices at Rugby.

Inaugural Address

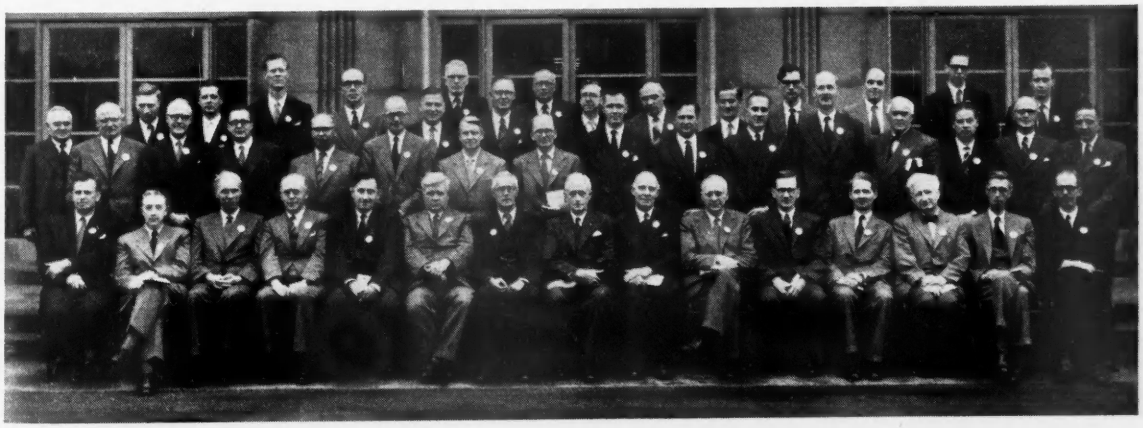
At the opening session of the course on Monday of last week the professors were welcomed by Mr. E. H. Ball, managing director of the company, who was introduced by Mr. L. J. Davies, director of research and education. In his opening remarks Mr. Ball apologised on behalf of the chairman of B.T.H., Lord Chandos, who would have delivered the opening address but was prevented from attending owing to illness. After reviewing the main features of the electrical industry and emphasising its vital importance in our national economy Mr. Ball said that it was in connection with professional engineers and their assistants the fields of endeavour of the manufacturing sides began to overlap.

Mr. Ball was quite sure that they, the company, would get the right quality of men from the universities and technical colleges, but he was equally sure that they would not get the quantity. Thus, they were placing great importance on the sandwich scheme and it appeared that they would recruit about two or three "sandwich" students to each graduate. In conclusion, Mr. Ball appealed to the professors to persuade their students to obtain practical training by apprenticeship in industry, whatever else they might do, since everything an electrical engineer did eventually depended upon a piece of apparatus designed, made and tested in the establishment of an electrical manufacturer.

University Courses

The inaugural lecture of the summer school was given by Dr. K. J. R. Wilkinson, who dealt with the university education of the electrical engineer. He said that the widening interests of the electrical industry called for an equally widening knowledge of the sciences by means of which the industry grew. To a certain extent this demand was met by recruiting graduates in physics and other sciences, but the vital need was that engineers should themselves have a broader scientific knowledge. It was accordingly advocated that the physics content of the engineering undergraduate's education should be emphasised. This step would mean less technology for the engineering undergraduate, but it should help to recruit to the profession a more effective share of those elusive few who were capable of detached and inventive thought —those who now found themselves considerably attracted by the remarkable developments in physics—and would better fit graduate engineers for a creative professional life.

The five lectures which were delivered on Tuesday were



Group photograph of those attending the third B.T.H. Summer School in Electrical Engineering at Rugby.

Seated left to right: Prof. W. Fishwick, Prof. E. Bradshaw, Prof. G. W. Carter, Prof. E. G. Cullick, Prof. G. H. Rawcliffe, Mr. G. S. C. Lucas, Prof. E. B. Moullin, Mr. E. H. Ball, Prof. H. E. M. Barlow, Mr. L. J. Davies, Prof. E. Brailsford, Prof. J. Greig, Prof. B. Hague, Prof. J. C. Prescott, Prof. F. M. Bruce.

Standing: Mr. C. H. Chaplain, Mr. G. A. T. Burdett, Mr. F. D. Gunton, Mr. A. Draper, Dr. G. L. d'Ombrain, Mr. M. W. Humphrey-Davies, Mr. E. A. Reeves, Prof. P. L. Burns, Mr. J. M. Layton, Mr. H. G. Foster, Dr. P. F. Soper, Mr. W. Cooper, Mr. J. G. Fleming, Dr. E. Wilkinson, Mr. C. Grad, Dr. D. O. Bishop, Mr. T. McGreevy, Mr. N. C. Stamford, Dr. H. Buckingham, Prof. J. E. Parton, Mr. C. T. Rivington, Prof. G. R. Bozzoli, Mr. R. F. Masters, Dr. J. F. Gillies, Prof. S. A. Prentice, Dr. L. G. A. Simms, Dr. J. C. West, Prof. M. G. Say, Prof. N. M. MacElwee, Mr. A. R. Pollard, Mr. R. Baldwin.

given by young men who had been awarded research fellowships by the company and the lectures described the work which they had done during the two years' duration of the fellowship. First Mr. P. H. G. Allen of the Transformer Engineering Department dealt with the distribution of temperature in a layer-type transformer winding. He viewed the prediction of thermal characteristics of a transformer winding as a particular solution of a more general problem. Mr. Allen briefly discussed the difficulties in the way of solving the problem and the methods employed to overcome these difficulties, emphasis being placed on some of the interesting phenomena encountered.

In discussing the design of insulation structures for high voltage transformers Mr. R. E. James of the Transformer Engineering Department gave a brief description of the insulation requirements in h.v. transformers. He discussed the problems involved and referred to investigations into the dielectric behaviour of the oil-immersed insulations, particularly laminated paper structures. The next lecture was given by Dr. P. C. McNeill of the Research Laboratory, who dealt with the electrical design of magnetron cathodes and described the relationship between magnetron operation and the thermionic and secondary emission from the cathode; the properties of the ideal magnetron cathode; experimental results; limitations of conventional cathode design; and new types of cathode construction.

Mr. T. A. K. Williams of the Electronics Engineering Department then described a rotary standing-wave detector with reference to an X-band model. The theory was explained briefly and the sources of error mentioned. This instrument is incorporated in an automatic impedance plotter and Mr. Williams discussed a block diagram of the system. The day's proceedings were concluded by Mr. A. J. Gilbert of the Plant Engineering Department who described a programme of work which he began three months ago in investigating the problem of open-circuit core losses in synchronous machines.

Automatic Controls

The first three lectures on Wednesday morning were presented by members of the Electronics Engineering Department and were concerned with automatic controls for industrial applications; Mr. L. C. Ludbrook began by dealing with servomechanisms and electronics in modern automatic production. Mr. M. Monk then described automatic co-ordinate setting from punched cards for the control of boring machines and similar machine tools. To conclude the session Mr. J. A. Stokes presented a review of electronic control applied to automatic reproduction of two- and three-dimensional forms from templates and models.

In the next session Mr. A. C. Lane of the Motor Engineering Department gave an inquisitional survey of commutation which showed that in the realm of electrical machine design, the flow of current over a sliding junction was one of the least understood subjects. In this lecture Mr. Lane made an attempt to discover why paths cut through this jungle were almost immediately overgrown and which paths, if any, were permanent. Mr. J. Whitcroft of the same department followed by giving an account of investigations which he had made into commutation and current collection during the past three years.

On Thursday morning three papers were presented by members of the Industrial Engineering Department. Mr. I. S. Robertson began by describing the torque control for a wind tunnel drive. This drive is a composite Ward-Leonard/induction motor drive in which the fan speed is regulated on the d.c. circuits and the d.c. load is kept constant. Variations in fan load are taken up on the induction motor by means of a novel slip regulator control. Mr. D. W. Prowse then stated the problems associated with the design of closed-loop control systems for a.c. mine winders and differentiated between the requirements for automatic and manual operation. In conclusion an analytical method of predicting the performance of electric motors under dynamic braking conditions was explained by Mr. J. C. Gosling.

Nuclear Engineering

Friday morning's session was opened by Mr. D. F. Welch, formerly of B.T.H. and now with the A.E.I.-John Thompton Nuclear Energy Group, who explained the function of the engineer in the nuclear power field. He said that the burden of work fell not upon the physicist who had already made invaluable contributions, but upon the metallurgist and engineer. In the engineering field the mechanical engineer carried the major burden, for on him lay the crucial problems of heat transfer and the mechanical operation of the plant. The lecturer reviewed typical problems showing the need for fundamental thought coupled with a more exact knowledge of the mechanisms involved.

Next, Dr. J. S. Jackson, of the Research Laboratory, described the critical properties of the various components of nuclear reactors. The manner in which suitable materials were selected was reviewed with particular reference to the erection of a gas-cooled, graphite-moderated thermal reactor of the Calder Hall type and a liquid-metal-cooled fast reactor of the type being constructed at Dounreay in Scotland.

In an introduction to a lecture on electromagnetic pumps for liquid metals, Mr. L. R. Blake, of the Research Laboratory, discussed the relative merits of these and mechanical pumps for the same purpose. After outlining the principle of operation of the electromagnetic pump, the following types of pumps were examined in greater detail: the d.c. conduction pump, the a.c. conduction pump, the spiral induction pump, the linear induction pump; the equivalent circuit of each type was deduced and practical pumps were described.

The final session of the summer school was opened by Mr. I. Williams, of the Research Laboratory, who gave an introduction to the basic properties of semi-conducting materials. He outlined the mechanism of conduction in this type of material, and some of the factors affecting it, and described experiments which are being carried out to assess and control the properties of germanium and silicon. Next, the various steps in the development of a semi-conductor device were discussed by Mr. R. G. Hibberd, of the Research Laboratory, with special reference to the different branches of science involved. By way of illustration, the development of a silicon junction rectifier was described. The lecturer emphasised that, for this work, a good general science training was preferable, coupled with some practical engineering experience. Finally, Mr. W. M. Simpson, of the Germanium Rectifier Department, dealt with the construction and method of manufacture of the 50 A fused-junction germanium rectifier.

During the course, those in attendance had an opportunity of inspecting the research laboratories at Rugby and the company's Birmingham motor factory. On Wednesday evening the whole assembly, as guests of the B.T.-H., saw a performance of *Othello* at the Shakespeare Memorial Theatre, Stratford-on-Avon, and on Friday there was a visit to the Rugby College of Technology and Arts, by kind permission of the Principal, Mr. W. Cooper.

PARLIAMENTARY REPORT

IN the debate on the factory inspectorate, Mr. F. Lee said there should be a higher ratio of inspectors with technical or scientific degrees. The pre-war percentage was between 60 and 70, but it had fallen since the war quite alarmingly to only 16 per cent.

Mr. Robert Carr, Parliamentary Secretary, Ministry of Labour, said there were 150 sets of safety regulations. Because of the need for revised regulations a thorough review was being made at the Ministry; about a dozen codes were in various stages of preparation or revision. The new ones included regulations relating to ionising radiation, works of engineering construction, ship building and repairing, lighting, horizontal mill machines, power presses and the fencing of abrasive wheels. It was hoped that the code relating to ionising radiation would be completed by early next year, and several other new codes would be made in the next year or two.

The Government intended to try to attract more technical graduates to the inspectorate, which was to be increased in size, but they preferred not to fix a proportion. It was in the staffing of the special branches that the inspectorate could make the fullest use of scarce technical manpower. The strength of the engineering and chemical branch, at present 18, was to be increased to at least 44 so that one engineering and one chemical inspector could be stationed in each division.

Mr. Nabarro said the high-speed electric router was a most dangerous machine. It was first used in 1934 for woodworking purposes but later, under the impetus of an expansion in aircraft production, its uses spread to non-ferrous alloys. To-day it was ubiquitous. Its spindle revolved at a speed higher than that of any machine tool commonly used in this country. No attempt had been made to bring the regulations up to date, although many accidents had occurred from just this one type of machine.

Mr. Raymond Gower stressed the importance of bright and attractively illuminated workshops.

Government action upon the findings of the Medical Research Council—published in the "Report on the Hazards to Man of Nuclear and Allied Radiations" as they affected industry were outlined by Mr. R. H. Turton, Minister of Health. He said that firms using radioactive isotopes were visited by the factory inspectorate to ensure that the precautions were adequate and an advisory booklet had been issued. Regulations had already been made to protect the workers in factories using luminous compounds. More general regulations covering other uses of radioactive substances would be published early in the new year. The Radioactive Substances Advisory Committee, under the chairmanship of Sir Charles Darwin, had now prepared a comprehensive code of practice for X-ray diagnostic and therapeutic work and in using radioactive substances. A Radiological Protection Service had been set up by the Ministry of Health and the Medical Research Council and would extend the work carried out for many years by the National Physical Laboratory.

The report had also suggested that irradiation from such sources as pedascopes, luminous watches and clocks, and television apparatus should be reduced as far as possible. The first of these was already under review by a panel of the Radioactive Substances Advisory Committee, and he was inviting the Committee also to review the other sources and to advise him about them as soon as possible.

Dounreay Reactor

Mr. Hector Hughes asked the Lord Privy Seal if he would make a statement on the present and future development of the nuclear power station at Dounreay, with particular regard to its relation to power for domestic and industrial purposes in Scotland.

Major Lloyd-George said Dounreay was primarily a research and development establishment. An experimental model of a fast breeder reactor capable of producing power was under construction and electricity generating equipment with a capacity of 15,000 kW was being installed. Owing to the experimental nature of the project, however, it was not yet possible to forecast when, or on what scale, it might provide a continuous supply of electricity.

Mr. Hughes asked if that meant that the station's power would ultimately be used for the much-needed industrial development of the North of Scotland.

Major Lloyd-George said it was an experimental station. The provision of other stations in Scotland was being considered.

Science Teachers

Mr. Stan Awberry asked the Minister of Education what was the estimated shortage of science teachers and when he anticipated that the supply would catch up with the demand both in the teaching profession and industry.

Sir David Eccles said he could not say how soon the supply of science teachers would match the demand. Between 600 and 700 graduates in science and mathematics were preparing for teaching at university departments of education, and some 500 other graduates in these subjects were likely to enter the schools this autumn. Two hundred and fifteen students had enrolled for third-year courses in science and mathematics at training college, compared with 59 a year ago. The new salary scales for teachers should have a stimulating effect on recruitment.

Egyptian Trade Mission

Mr. Bottomley asked the President of the Board of Trade what was the scope of his official talks with the Egyptian Minister of Commerce.

Mr. Low, Minister of State, said the Government welcomed the Egyptian Trade Mission which was headed by the Minister of Commerce and arrived on 8th July. Their purpose was to foster the expansion of trade between our two countries as was the purpose of the 1955 British Trade Mission to Egypt. They would be meeting businessmen concerned in trade with Egypt in London, Lancashire and Scotland. He and the President of the Board of Trade had had talks with the mission and would be meeting them again before they left.

Loans for Commonwealth Projects

Mr. Hugh Fraser asked the Chancellor of the Exchequer whether he would give an assurance that, in future, when large sums of money were loaned by the Government, or its agencies, for Commonwealth projects conditions would be made to ensure that contracts were awarded to British or Commonwealth firms, bearing in mind the grip of the credit squeeze on British enterprise and work in progress.

Mr. Henry Brooke, Financial Secretary, said that it would not be in our wider interests to lay down a condition that all our loans should be available only for U.K. goods and services. Specific decisions could be taken only in individual cases, in the light of what was desirable and practicable.

Mr. Fraser said that after the experience of the allocation of the Kariba dam contracts the Minister must surely agree that there were major political considerations which must be borne in mind. Could the Government give an assurance that there would be no repetition of the bad organisation which led to that fiasco?

Mr. Brooke denied that there had been bad organisation in the Kariba project. It would not have been possible to find the funds needed in the United Kingdom for this development as well as for other developments within the Federation of Rhodesia and Nyasaland. It was necessary to interest the International Bank in the project and the Bank laid down the condition that contracts which were covered by its financing must be open to international tender.

Sir Roland Jennings said that in view of the unsatisfactory Government reply he would raise the subject again in an adjournment debate.

INDUSTRIAL NEWS

Resistance Welding Machine Export Drive

A new export drive by British resistance welding machine manufacturers was inaugurated at a special luncheon held last week at the Connaught Rooms, London, when the principal speaker was Mr. L. H. Robinson, C.B., of the Board of Trade. A special booklet has been published for overseas distribution, demonstrating the many different ways in which resistance welding can be applied to old and new methods of manufacture. It is emphasised that resistance welding is one of the fastest production processes used in industry and marked economies in production can be achieved. Illustrations are included of some of the diverse products that are made with the use of electric resistance welding.

Mr. J. M. Sinclair, M.B.E., J.P., M.I.Mech.E., chairman of the Resistance Welding Machine Section of the British Electrical and Allied Manufacturers' Association, thanked Mr. Robinson for the Board of Trade's interest in this new export drive, and said that they proposed to pay special attention to countries where there was a trend towards industrialisation, where adequate electric power was available for industrial use, and where a good foreign exchange potential existed.

South African Broadcasting Station

The South African Broadcasting Corporation's biggest broadcasting station, at Paradys in the Orange Free State, came into partial operation on 1st July. It is to be officially opened in October or November of this year. The station represents to Britain an export order of approximately £240,000 worth of radio equipment. Marconi's Wireless Telegraph Co., Ltd., have supplied nine of its type BD.262 series of 20 kW h.f. broadcasting transmitters, together with ancillary equipment. Marconi engineers are assisting with final adjustments on the site, but most of the installation is being carried out by S.A.B.C. personnel. At the present initial stage of the service four transmitters are being used to radiate the English and Afrikaans service within the frequency band 2.3-15 Mc/s. A further four transmitters, operating in the 4.7-26.1 Mc/s frequency band, will come into service at a later date. Three will be used for a service to territories to the north of the Union of South Africa. The ninth transmitter has not as yet been allocated to a specific service.

Thailand Telecommunications Contract

Against strong international competition, the Automatic Telephone & Electric Co., Ltd., has been awarded three important contracts, valued at over £100,000, for the supply and installation of Thailand's first long-distance telecommunications network. Part of the cost of the order, which has been placed by the Royal Thai State Railways, will be met by American aid, bringing more than $117,000 to Britain. The project calls for the provision of an extensive trunk telephone and telegraph system linking the State Railways' Bangkok headquarters with eleven provincial traffic control centres throughout the country. Two new trunk telephone lines are being built over all sections of the network, which when completed will have a total route length of 2,500 km. (1,560 miles).

As this will be the first modern communications equipment to be installed in Thailand, arrangements have been made for Thai maintenance engineers to come to Britain to be trained at the A. T. & E. Liverpool factory. An engineer from the company will also supervise the installation work in Thailand, which will be carried out by members of the staff of the State Railways' signal and telecommunications engineer. Each traffic control centre on the railway network will have both telephone and teleprinter switchboards, with direct connections to Bangkok and adjacent centres. Diesel alternators are being used to power the installations. In addition to the traffic control centres, ten other stations throughout Thailand are being provided with trunk telephone connections.

The carrier telephone and audio-frequency telegraph equipment will be manufactured at the A. T. & E. Strowger Works, Liverpool; carrier telegraph equipment, telephone switchboards and telephones will be supplied by the Telephone Manufacturing Co., Ltd.; and Petbow, Ltd., is supplying the diesel alternators. The order was negotiated through Steel Brothers & Co., Ltd., agents in Thailand for A. T. & E. and the Copperweld Steel International Co., of New York.

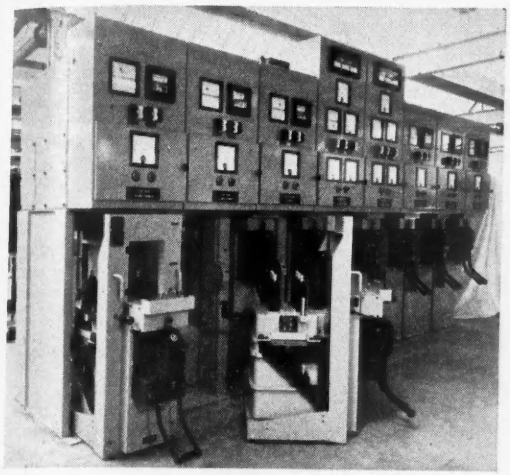
Duplicate Busbar Switchboard

Johnson & Phillips, Ltd., have added to their range of metalclad switchgear a new duplicate busbar unit, Type DBB 16/A, incorporating their TSB or TDB 16 vertical isolation pattern oil circuit-breakers, A.S.T.A. certified for rupturing capacities up to 250 MVA at 11 kV.

The eight-panel switchboard shown in the accompanying photograph has DBB 16/A units fitted with TDB oil circuit-breakers of the vertical isolation pattern, with a certified breaking capacity of 100 MVA at 313 kV. The two incoming feeder panels have breakers of a continuous current rating of 800 A, whilst the outgoing feeder oil circuit-breaker has a current rating of 400 A.

Busbar selection interlocks are provided, there being a busbar selector on the front of each panel, with an indicator showing which set of bars has been selected. After selection, the breaker carriage is pushed into the housing until a positive stop is felt. An interlock slide bolt can then be positioned into the registering hole in the indicator plate and thus allow the winding handle to be fitted on to the winding shaft and the breaker raised to the service position. The selector can,

The Transmitting Hall of the Paradys Broadcasting Station, South Africa



3.3 kV double busbar panel of new design, by Johnson & Phillips

of course, be padlocked in a given position and padlocking facilities are incorporated to prevent unauthorised operation of the interlock slide bolt; to enable the o.c.b. to be kept "plugged-in," earthed or isolated; and to secure the safety shutters over the spouts when earthing circuits. The usual complement of mechanical safety interlocks is provided and there are duplicate sockets, parallel wound, for either position of the breaker when plugged-in to either set of bars.

O.E.E.C. Report

The Organisation for European Economic Co-operation (O.E.E.C.) has issued the third edition of "At Work for Europe," being an account of the activities of the Organisation. The booklet includes a contribution by Jan van den Heuvel, head of the Energy Division of the O.E.E.C., on "Intra-European Co-operation in the Field of Energy," dealing with coal, oil, gas and electricity. This records the steps taken under the Recovery Plan, leading to the formation of the Commission for Energy last year, and the setting up by the Council of Ministers of a special committee to deal with nuclear energy. As an indication of the results achieved in the O.E.E.C. area during the post-war period, a table shows that electricity production rose from 180,300 million kWh in 1947 to 332,200 million kWh in 1954. Free copies of the booklet can be obtained from the O.E.E.C. Information Division, 2, rue André-Pascal, Paris, 16e.

Millers' Demonstration Kitchen

A demonstration kitchen has recently been opened at the "Frenlite" flour mills of J. W. French & Co., Ltd., Ware, Herts. The company, which was founded in 1855, has for many years milled flour for bread-making but more recently it was decided to mill a high-quality flour for domestic use and the new kitchen has been developed to demonstrate the qualities of the flour. Interested parties are invited to follow the progress of flour milling from the wheat, through its various stages, cleaning, brushing, grinding and rolling, and milling.

There is seating accommodation for approximately 40 persons in the kitchen and use is made of many electrical appliances, including a Tricity cooker, Electrolux refrigerator, Kenwood "Chef" mixer, Jackson water boiler, Russell Hobbs kettle, Hawkins wall clock, etc., much of the apparatus having been given by the manufacturers themselves. In addition to general fluorescent lighting Courtney, Pope "Hyliter" spotlight fittings are used. The cookery advisory staff is under the direction of Miss Ursula Jackson.

Course for Technical Teachers

Garnett College, 83, New Kent Road, London, S.E.1, has vacancies in the course starting next September for engineers wishing to become full-time teachers of technical subjects. The course, which lasts for about nine months, is one of teacher training and does not include instruction in subject matter, the aim being to prepare students for work in technical schools and colleges. Details can be obtained from the principal of the College.

English Electric Window Display Contest

In a window display contest held by the English Electric Co., Ltd., during June and July and open to over 4,000 authorised appliance and television dealers, the national prize of £50 was awarded to a Scottish dealer. In addition, three prizes were offered for winning displays in each of eight areas covering the whole country. Mr. H. C. Timewell, manager of the English Electric Co.'s domestic appliance and television division, in naming the prizewinners, also announced the company's intention of making this competition an annual event.

The Aberdeen Electrical Engineering Co., Ltd., was judged the national award winner and in addition gained first prize for the Scottish area. Cheques totalling £70 were presented by Mr. A. M. Parkinson, sales manager of the English Electric appliance division, in Aberdeen on 23rd July. The theme of the winning display was the electrical home laundry, which followed the idea of the English Electric advertising slogan "Bringing you better living" by offering housewives the means of increasing their leisure time. The judges were Mr. Timewell, Mr. C. T. M. Bagnall (publicity manager, English Electric Co.), Mr. F. A. Nicholson (Leggett, Nicholson & Partners), and Mr. A. Smith (Fellow of the Society of Industrial Artists).

The National Winning Display in the English Electric Co.'s window display contest

Contract Price Adjustment Formulæ

The British Electrical and Allied Manufacturers' Association has issued the figures for its contract price adjustment formulæ. In each case the rate of pay for adult male labour at 14th July is deemed to be 175s. The "cost of materials" figures are: For electrical machinery and equipment, the Board of Trade index figure published on 14th July is 184.3. For turbo-generating and allied plant: Materials used in mechanical engineering industries, 176.0; blast furnaces and iron and steel melting and rolling (40 and 41), 167.3. The price of $\frac{3}{4}$in o/d 18 s.w.g. brass condenser tubes (*Metal Bulletin*, 13th July) is 4s $1\frac{1}{4}$d per lb.

C.S.A. - Approved Equipment

The B.S.I./CSA Approvals Agency operated by the British Standards Institution on behalf of the Canadian Standards Association has just published a second edition of its "List of U.K. Equipment CSA Approved." This approval means that the products can go straight into service in Canada without the risk of being returned to Britain for modification to meet local Canadian regulations. The annual value of British electrical exports to Canada exceeds £9 million, and as most

of it is now CSA-approved in advance by B.S.I. this represents a service of very great value to exporters. The new list is sectionalised by type of product, and gives the manufacturers' names alphabetically, with the goods for which they have secured approval. In total, many thousands of items are listed. The names and addresses of the manufacturers' Canadian representatives are also included. Copies of the List can be obtained, free, from the British Standards Institution, Sales Branch, 2, Park Street, W.1.

Osram Air Race Cup

This year, for the first time, the General Electric Co., Ltd., is marking its interest in aviation by presenting one of the trophies, the Osram Cup, in the National Air Races at Baginton Aerodrome, Coventry. The Cup is the only trophy which is being won outright, the others being raced for each year. The Osram Cup Air Race is flown over four laps of an eight-mile course, in three rounds. The first two rounds were flown at Yeadon Airfield, near Leeds, on Whit Monday, and the third and final round was flown at Baginton on Saturday last.

Generating Plant for Australia

The General Electric Co., Ltd., has been awarded contracts to the value of £2½ million for generating plant to be installed in Australia. Two 60 MW hydrogen-cooled turbo-alternator sets are being supplied to the New South Wales Electricity Commission for Wallerawang power station, this contract including condensing and feed heating plant. Steam conditions of the turbines are 900 p.s.i.g. pressure and 900 deg. F. temperature at the turbine stop valve; vacuum at m.c.r. (full load) 28.2in and final feed temperatures 385 deg. F. The hydrogen cooling will operate at a pressure of 30 p.s.i.g. and the sets will generate at 11 kV.

One 30 MW turbo-alternator is to be supplied to the Mount Isa Mines, Queensland, complete with feed heating and condensing plant. Steam conditions of the turbine are 900 p.s.i.g. pressure and 850 deg. F. temperatures at the stop valve; the m.e.r. vacuum at 24 MW is 28.2in and final feed temperatures 335 deg. F. The generator is air-cooled and generates at 11 kV.

Mazda "Queen of Light"

For the third year the organisers of the Mazda Queen of Light Competition are searching for a blonde between 16 and 30 years old to be crowned British Queen of Light. The A.E.I. Lamp and Lighting Co., Ltd., has taken over the sponsorship of this competition. This year there are some twenty more preliminary contests than last year and it has become necessary to hold a semi-final in each of the company's six sales regions. Altogether some fifty local Queens of Light will be chosen in industrial towns, capital cities and seaside resorts during the summer and autumn. The first three heats have been held this month in Skegness, Llandudno and New Brighton.

Publicity and display material available for dealers includes a colourful showcard dispenser for leaflets and entry forms, which may be stood or hung, posters, gummed stickers and special window display. The competition will be supported by an advertising campaign in local papers throughout the country.

Diesel Generators for Venezuela

Mirrlees, Bickerton and Day, Ltd., have recently received orders for five diesel electric generating sets to be supplied to various sites in Venezuela. A KS6 six-cylinder, turbo-charged in-line engine developing 1,362 b.h.p. continuously at 450 r.p.m. on site direct coupled to a 960 kW, 4,160 V, 3-phase, 60 c/s alternator will be installed at the San Felipe power station of Luz Electrica de Venezuela C.A. Two Mirrlees/Brush 216 kW diesel elecric generating sets each comprising a Mirrlees TL6 six-cylinder, naturally aspirated, in-line engine developing 315 b.h.p. continuously on site at 600 r.p.m. are to be installed at El Mohan power station of the Consejo Municipal de San Rafael de Mohan. Each is direct coupled to a 216 kW alternator manufactured by Brush Electrical Engineering Co., Ltd., Loughborough. Two 214 kW diesel electric generating sets each comprising a Mirrlees TL6 six-cylinder, naturally aspirated, in-line engine developing 310 b.h.p. continuously on site at 600 r.p.m. are being supplied to Campenon Bernard de Venezuela for installation at Caroni Dam. Each is direct coupled to a Brush 214 kW alternator. In addition to the heat exchangers, coolers and Petter-Reavell compressor set Mirrlees is also supplying the Brush alternator control panel, synchronising panel and switchgear. The orders for all this equipment were obtained by Mirrlees' associate company, the Brush Group de Venezuela S.A., Caracas.

Large New Letchworth Factory

On 17th July Borg Warner, Ltd., initiated their new factory at Letchworth, Herts, built to produce fully automatic transmission units for cars, and overdrive units. On a site of 11 acres the building gives 198,000 sq ft of single floor productive space. The complete plant, which has cost about £4 million and has taken only 13 months to complete, is planned for the production of 500 automatic transmissions and 250 overdrives per day.

Four substations supply a maximum load of 5,500 kVA and four automatic oil-fired boilers produce a total of 28,000lb of process steam per hour. Compressed air is used considerably and six double-acting compressors, with after-coolers, produce 4,400 cu ft per hour.

Change of Name

Avis & Baggs, Ltd., Reading, have changed their name to Andec, Ltd.

Annual Holidays

The works of S. I. Engel, 23-25, Kensington Park Road, London, W.11, will be closed for the annual holiday from today (Friday) until 13th August.

Trade Announcements

Mr. H. H. Leage whose agreement as London agent with Long & Crawford, Ltd., Manchester, terminates on 31st August next, states that he is still continuing in business as manufacturers' agent at 50, Lincoln's Inn Fields, W.C.2.

Runbaken Electrical Products has moved its head office, sales and service departments and accounts offices to its new building at 45, Oxford Road, Manchester, 1.

The stand of the South Eastern Electricity Board at the recent Kent County Agricultural Show held at Mote Park, Maidstone

NEW ELECTRICAL EQUIPMENT

Toroidal Regulator

FOSTER TRANSFORMERS, LTD., South Wimbledon, S.W.19, announce the introduction of a toroidal regulator, designed to provide a reliable means of obtaining an infinitely variable "on-load" voltage control from zero to maximum. The unit is for an input voltage of 240 V or 120 V. The output current is 3 A from 0-250 V. The price for the open type is £8 6s each and for the enclosed type £9 16s each.

Enclosed type Foster toroidal regulator

Universal Measuring Instrument

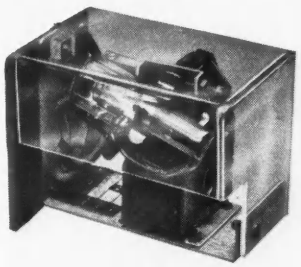
A compact instrument which can be used for measuring a.c. or d.c. voltages and currents, resistances and capacitances is now available from PHILIPS ELECTRICAL, LTD., Century House, Shaftesbury Avenue, London, W.C.2. Measurements—except those of direct voltage and current—are made electronically, achieving, it is claimed, greater accuracy than is possible with conventional moving-coil instruments.

Known as the GM.6008, the equipment has ranges of 20 mV to 1 kV d.c.; 100 mV to 300 V a.c. at 20 c/s-100 mc/s; 10 μA to 1 A d.c.; 0.1 μA to 10 mA at 20-1,000 c/s and 10 μA to 1 A at 20 c/s-100 kc/s, a.c.; 1 ohm to 1,000 Megohms and 30 pF to μF. The instrument is provided with a switch to reverse polarity when measuring positive and negative voltages in succession. Calibrating voltages of 1 V and 30 V are built in and the instrument is fully protected against overloading. Contained in a grey lacquered case measuring 13in × 8¾in × 7½in, the GM.6008 weighs approximately 18½ lb.

Mercury Relay

A new mercury relay is now being produced by ENGEL & GIBBS, LTD., Warwick Road, Boreham Wood, Herts, combining most features of their standard E.G. relay, but occupying half the total volume. The new relay is suitable for operating all types of time switches up to 15 seconds, and single-pole straight make/break switches up to 30 A.

Two models are available. The first one is mainly intended for use in conjunction with standard 3000 pattern telephone relays and occupies the space of two telephone type relays. It is made in two mounting versions, left and right. This refers to the positioning of the connection spills extending from the back of the paxolin base. The unit is provided with a Perspex protective cover. Complete adjustment is available for movement of spring tension, and this can be carried out, if necessary, with the relay *in situ*.



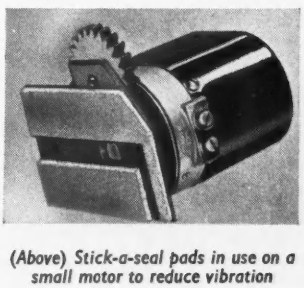
Engel & Gibbs relay: this type is intended for use in conjunction with 3,000 pattern telephone relays

The other type is suitable for normal panel mounting and is provided with a flat plate fitted with two fixing holes. It incorporates the basic coil mechanism of the above relay. The quick-make, quick-break designs are available for ratings of 5, 15 and 30 A, and the contacts can be normally open or normally closed.

Self-Adhesive Sealing

"Stick-a-seal" self-adhesive polyurethane foam, made by SEALDRAUGHT, LTD., Chandos House, Buckingham Gate, London, S.W.1, is now being produced in a range of thicknesses and widths suitable for industrial application. In the radio, television and electronic fields it is used in strips or stamped shapes to mount and bed units and components. Speakers mounted on this self-adhesive foam have been found to give increased fidelity.

Television manufacturers find it useful material for sealing the front assembly of the screen to prevent the entry of dust particles attracted by the high electrostatic charge of the c.r. tube. It is produced in standard thicknesses of $\frac{1}{8}$in, $\frac{3}{16}$in, and $\frac{1}{4}$in, but thicker grades up to $\frac{3}{4}$in can be specially made. There is a variety of widths readily available up to 4in wide, but it may be obtained up to a maximum of 19in wide. The length of the roll is from 13ft to 25ft, depending on the thickness of the material.

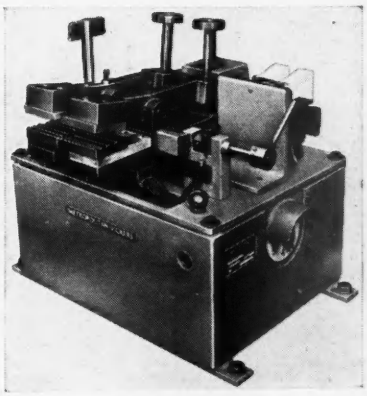


(Above) Stick-a-seal pads in use on a small motor to reduce vibration

Butt Welding Machine

A new 6 kVA butt welding machine has been built specially for the welding of high carbon steel wire by the METROPOLITAN-VICKERS ELECTRICAL CO., LTD., Trafford Park, Manchester, 17, capable of welding wire ranging in diameter from 8 gauge to 3/0 gauge (0.372in). A 2½ kVA machine of similar design is also available for welding wires up to 5 gauge. The new machine has a single phase transformer for connecting to a 440 V supply. Adjustment of the gap between the jaws is obtained by rotating the left-hand pointer to the appropriate gauge size engraved on the dial plate. The wires are clamped in the jaws by screwing the two knobs in a clockwise direction and the weld is then made by operating the right-hand lever, which switches on the welding current.

Post-weld heat treatment is obtained by depressing the flush mounted push button at the front of the machine and keeping it closed for a period sufficiently long to allow the temperature of the wire to rise to the correct value.



(Right) The 6 kVA butt welder with cover removed

GENERATION AND DEVELOPMENT

Electricity Generation by Industry

The Ministry of Fuel and Power's monthly statistics of electricity generated now include, in addition to information on public supply, figures for some of the country's chief industries. The accompanying table shows electricity production by these industries in the first half of this year and the increase or decrease compared with the corresponding period of 1955. Railways and transport undertakings, coal mines, gas works and petroleum refineries are not included as in their case only annual statistics are available.

Industry	Electricity Generated (million kWh)		
	26 weeks 30th June, 1956	ended 2nd July, 1955	Per cent
Chemicals	1,397.0	1,306.9	+ 6.9
Iron and Steel ..	1,122.2	1,104.9	+ 1.6
Engineering* ..	660.1	682.8	− 3.3
Textiles, leather and clothing	341.0	348.3	− 2.1
Food, drink and tobacco	136.5	150.5	− 9.3
Paper	1,084.9	1,065.5	+ 1.8
Other industries ..	220.9	265.6	−16.8
Total	4,962.6	4,924.5	+ 0.8

* Including non-ferrous metal manufacture.

New Service Centre

The North Western Electricity Board has opened a Service Centre to cater for the 20,000 population at Ashton-in-Makerfield, near Wigan. The new Centre, in Bryn Street, a conversion from a café, was opened by the vice-chairman of the Ashton Council, Alderman R. L. Hughes. For many years the Board has been asked to provide a Centre in this area, and it will be especially appreciated by housewives, who will no longer have to travel four miles to Wigan to buy appliances and pay accounts.

In addition to normal Service Centre facilities, cookery demonstrations will be held in the new premises from the end of the month.

Douglas Engineer's Report

In his 1955-56 report the borough electrical engineer and manager of Douglas, I.O.M. (Mr. C. Anderson, M.I.E.E., M.Inst.F.), says that although the cost of coal was raised by 18 per cent in July, 1955, it had been recommended that tariffs should remain unaltered in anticipation of further development in the use of electricity. Total sales in the area last year were 21.2 million kWh, an increase of 7.2 per cent. In spite of higher operating costs, and loan charges there was a net credit balance of £5,686. Domestic appliances on hire at the end of March last numbered 8,752 against 8,186 a year before.

South Wales Board's Programme

Details of the South Wales Electricity Board's revised programme of capital works for the current financial year were announced at a meeting of the Consultative Council last week. The estimated expenditure of £5,115,000 is £685,000 less than normal requirements, the reduction having been made to meet the Government's request for restriction of capital expenditure at the present time. A sum of £2,300,000 is to be spent on reinforcement works to improve existing supplies and to augment the capacity of the system; £1,250,000 on works in rural areas (including a special allocation of £115,000 made because of the large amount of work still to be done in the rural areas of South Wales); and £1,466,000 has been allocated for works to afford new supplies for industry, commerce, new housing, public lighting, etc. Expenditure under other heads has been severely curtailed. Building projects designed to improve administrative efficiency have been deferred and the rate of progress on system standardisation will be very much slower than during 1955-56.

Electricity Finance in Queensland

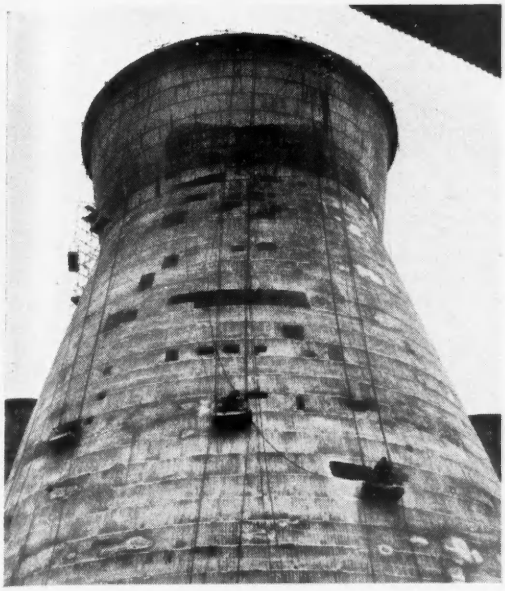
The Southern Electric Authority of South Queensland (156, Boundary Street, Brisbane), the successor to the City Electric Light Co., Ltd., Brisbane, has sent us a brochure describing its variable interest stock. This is an unusual form of security; the annual rate of interest varies with the rate of interest payable on Commonwealth loans and this rate is always 2 per cent above the Commonwealth loan rate. The stockholders also have the right to appoint five of the seven members of the board of the Authority. The stock has a 15-20 year term and may be converted after June, 1968, into Government guaranteed stock bearing an equivalent but fixed rate of interest (2 per cent above the current Commonwealth loan rate) secured on the Authority's undertaking.

The Authority's assets are valued at over £35 million and its annual gross revenue approaches £7 million.

Renovating a Cooling Tower

After more than 20 years' service, the No. 3 cooling tower at the Central Electricity Authority's power station at Brimsdown at last needed attention. This presented the problem of how to

Exterior and interior views of the North Western Electricity Board's new service centre at Ashton-in-Makerfield



Work in progress on the Brimsdown cooling tower

get access to the waist, which was so much narrower than the top and bottom, without the expensive necessity of erecting scaffolding all round it. The Steel Scaffolding Co., Ltd., solved the difficulty by erecting enough scaffolding to give access to the 2ft rim at the top, around which they built a guard rail and hung cradles. As the cradles hung vertically, means has to be found to draw them in to the narrow waist. This was done by running a cable round the tower from which leads ran to the cradles so that the men could draw themselves in to work on the sides.

Aswan Dam Offer Withdrawn

The United States Government last week withdrew its offer to assist Egypt in financing the Aswan High Dam project on the grounds of failure to reach agreement among the riparian States of the Nile on the division of the river's waters, and doubts about Egypt's ability to devote adequate resources to ensure the success of the project. It was subsequently announced that the British Government had also withdrawn its offer.

Cooking in Council Houses

Swadlincote U.D.C. is to consider the possibility of providing gas or electric cookers in houses to be built in the future. A survey of the houses on the Hartshorne estate revealed that only three tenants exclusively used the Council's combination cooking ranges and the Housing Committee is therefore to discuss whether this type of cooker should be dispensed with.

European-Power Interchanges

A new step in international co-operation has been taken by a decision of the O.E.E.C. Council recommending that European countries with interconnected grids should in future free seasonal exchanges of electricity from currency and other restrictions.

In the past, as the result of a Council decision of March, 1953, the Member countries concerned—Austria Belgium, France, Germany, Italy, Luxembourg, the Netherlands and Switzerland—agreed to authorise the import and export of electricity in order to avoid waste of hydro-energy or to provide emergency supplies required by a grid as the result of a breakdown in equipment. This resulted, during the period 1953-1955, in increasing the exchanges of electricity between the countries concerned by an average of 15 per cent per year; consumption rose by 9 per cent.

The new decision, which arises from a proposal of the International Union for the Co-ordination of Production and Transmission of Electricity (U.C.P.T.E.) and the O.E.E.C. Electricity Committee, means that the seasonal import or export of electric power for which agreements are made between the production and distribution undertakings of Member countries for periods of less than six consecutive months will also be free of restrictions, and that the foreign exchange required for import will be automatically provided.

Boards' Sales

The accompanying table analyses the sales by the twelve Electricity Boards in England and Wales last month. The national figures show an increase over June, 1955, of 9.4 per cent, but when corrected for weather conditions and working days, the increase is 8.3 per cent.

High Marnham Power Station

A contract worth £3¼ million for the first stage of the civil engineering construction work on the Central Electricity Authority's new power station at High Marnham, Nottinghamshire—the largest yet projected in this country—has been awarded to Taylor Woodrow Construction, Ltd.

The work on the first stage, which will take 3½ years to complete, includes the construction of main foundations for turbines and boiler plant producing 600,000kW. When complete the station will house five 200,000kW sets. The consulting civil engineers are Freeman, Fox and Partners.

Egyptian Electrification Scheme

A report on a general scheme for the development of electrical energy in Egypt during the new twenty years, and based on the assumption of the construction of the Aswan High Dam, has been made by Electricité de France under an arrangement with the Egyptian Permanent Council for the Development of National Production. Studies, covering many aspects of the problems of generation, transmission and distribution of electricity in different parts of the country have been carried out in close contact with the Egyptian Electricity Commission and Technical Bureau of the Permanent Council, and conclusions have been drawn as to future systems, and the administrative technical and financial requirements involved. A copy of the report, which is in three volumes and is not on sale, may be seen at, or loaned from, the Commercial Relations and Exports Department, Board of Trade, Room 5138, Horse Guards Avenue, London, S.W.1, quoting reference C.R.E./6527/56. (Telephone: Trafalgar 8855, Ex. 7516).

ELECTRICITY SENT OUT BY AREA BOARDS FOR THEIR CONSUMERS

Area Board	Totals for June (Million KWh)			Twelve Months Totals Ended June (Million kWh)		
	1955	1956	Inc. or dec. %	1955	1956	Inc. or dec. %
London	411.7	444.5	+ 8.0	6,323.7	6,801.1	+ 7.5
South Eastern	258.0	302.3	+17.2	3,833.0	4,277.4	+11.6
Southern	321.8	366.6	+13.9	4,626.9	5,127.0	+10.8
South Western	167.8	195.2	+16.3	2,395.4	2,625.9	+ 9.6
Eastern	431.7	482.6	+11.8	6,200.7	6,792.6	+ 9.5
East Midlands*	405.2	434.7	+ 7.3	5,418.9	5,835.6	+ 7.7
Midlands*	535.1	561.9	+ 5.0	7,211.6	7,617.2	+ 5.6
South Wales*	334.9	342.4	+ 2.2	4,158.3	4,427.4	+ 6.5
Merseyside and N. Wales*	324.1	349.4	+ 7.8	4,211.2	4,598.1	+ 9.2
Yorkshire*	543.3	575.6	+ 5.9	7,023.2	7,587.4	+ 8.0
North Eastern*	308.8	333.3	+ 7.9	4,089.4	4,364.4	+ 6.7
North Western*	556.4	601.5	+ 8.1	7,675.6	8,082.1	+ 5.3
Total all Area Boards	4,598.8	4,990.0	+ 8.5	63,167.9	68,136.2	+ 7.9
Direct Supplies by Central Authority	119.9	173.1	+ 44.4	1,661.2	2,069.5	+24.6
Grand Total	4,718.7	5,163.1	+ 9.4	64,829.1	70,205.7	+ 8.3
Mainly Industrial Areas*	3,007.8	3,198.8	+ 6.4	39,788.2	42,512.2	+ 6.8
Mainly Non-Industrial Areas	1,591.0	1,791.2	+12.6	23,379.7	25,624.0	+ 9.6

*Those in which industrial consumers took over 50% of the total sales in the preceding financial year.

PERSONAL AND SOCIAL

News of Men and Women in the Industry

THE Minister of Fuel and Power has appointed **Mr. C. M. Jones,** M.B.E., J.P., of Bala, Merionethshire, as a part-time member of the Merseyside and North Wales Electricity Board, and has reappointed **Mr. J. Rankin,** O.B.E., F.C.I.S., Companion I.E.E., of Lower Caldy, Wirral, Cheshire, deputy chairman of the Board and **Lt. Col. J. F. Williams Wynne,** D.S.O., of Towyn, Merionethshire, as a part-time member of the Board.

Alderman I. J. Hayward, LL.D., J.P., of London, S.E.4, has been reappointed as chairman of the London Electricity Consultative Council; **Group Captain J. C. M. Hay,** O.B.E., D.L., of Lyndhurst, Hants, as chairman of the Southern Electricity Consultative Council; and **Councillor H. Evans, J.P.,** of Liverpool, as chairman of the Merseyside and North Wales Electricity Consultative Council.

Mr. G. O. Watson, M.I.E.E., Fellow A.I.E.E., M.I.Mar.E., retired from the position of principal electrical engineer surveyor with Lloyd's Register of Shipping on 30th June, although he is being retained for the time being in a consultative capacity. Mr. Watson was educated at Battersea Polytechnic and received his training with the British Thomson-Houston Co., Ltd., Rugby, with whom he was engaged for some years on the design of control gear. He joined Lloyd's Register of Shipping in 1933 as senior electrical engineer surveyor, and in 1936 became principal electrical engineer surveyor.

Mr. G. O. Watson

He drafted Lloyd's Register's first rules for electrical propulsion of ships which were subsequently adopted as the basis of the I.E.E. Regulations. Since 1939 he has been chairman of the I.E.E. Committee on Regulations for Electrical Equipment of Ships and since 1947 of the I.E.C. Technical Committee No. 18, on Electrical Installations in Ships. He has been active in I.E.E. affairs having been a member of the Council (1953-56) and chairman of the Utilisation Section (1944-45). Among his other activities has been a member of the American I.E.E. Committee on Marine Transportation and of a number of B.S.I. Committees, including the Electrical Industry Standards Committee. He was president of the Batti-Wallahs' Society for 1955-56, and he has recently returned from Australia which he visited immediately prior to his retirement.

Mr. J. M. Hallett has been appointed publicity manager of Ferranti, Ltd. Educated at Bromsgrove School, Worcester, he started his career with Wm. Cory & Son, Ltd., in 1930. He joined Ferranti, Ltd., in 1935 on the sales staff of the Domestic Appliance Department. During the war from 1939-1945 he served with the Royal Tank Regiment and R.E.M.E. holding the rank of major. From 1945 to 1950 he was the Ferranti's outside representative for the Domestic Appliance Department covering London and South England. In 1950 he was appointed sales manager of the Domestic Appliance Department and held this post up to receiving his new appointment.

Mr. J. M. Hallett

Mr. M. H. St. Clair Barnes has been appointed sales manager of the Domestic Appliance Department of Ferranti, Ltd. He was educated at Mill Hill School and in 1943 attended a special course sponsored by the R.A.F. at Oxford University. Subsequently he served as a pilot in the R.A.F. holding the rank of flying officer until 1946. During 1946-47 he attended Oxford University (Brasenose College).

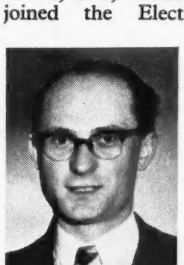
After a year with Simon Sound Service (London) and a year with Milford Astor (Manchester) he joined Ferranti, Ltd., and from 1950 to 1956 was engaged as outside representative for the Domestic Appliance Department for the North of England and Scotland, and latterly South-West England.

Mr. F. Mather a member of the staff of the chief engineer of the North Western Electricity Board has been appointed assistant chief engineer (technical) at headquarters, Manchester. Mr. Mather was educated at Manchester Central High School and the Manchester College of Technology. After experience with Ferguson, Pailin, Ltd., he entered the electricity supply industry in 1935, being appointed construction engineer of the Stalybridge, Hyde, Mossley and Dukinfield Transport and Electricity Board. He subsequently held the positions of substation engineer and technical engineer and distribution engineer to this authority. On nationalisation, Mr. Mather was appointed to the Board's No. 7 Sub-Area as sub-area engineer (technical), and joined the staff of the chief engineer in 1955.

Mr. L. C. Smith, assistant power sales engineer at the Board's Manchester headquarters, has been appointed district commercial engineer to Kearsley District in the No. 2 Sub-Area. Mr. Smith was educated at Arnold House School, Blackpool, and at Manchester, Bolton and Leigh Technical Schools. After a period in the textile industry, he joined (in 1933) the staff of the Lancashire Electric Power Co., becoming in 1946 the area consumers' engineer in the Whitefield and Ramsbottom area and being transferred in the same year to company headquarters as assistant power sales engineer. On nationalisation, Mr. Smith was appointed to the staff of the No. 2 Sub-Area headquarters as senior assistant power sales engineer, and went to headquarters in 1950.

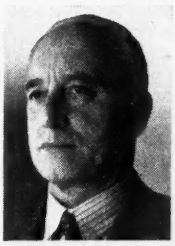
Mr. W. S. Gee, first assistant district commercial engineer in the Board's Oldham District, has been appointed district commercial engineer to Leigh District, in the No. 2 Sub-Area. Mr. Gee, who was educated at the Farnworth Grammar School, Worsley Technical College and the Manchester College of Technology, joined the Lancashire Electric Power Co. in 1926, becoming a sales development engineer and showroom manager after experience in the Meter Test Department and the domestic appliance workshops. In 1937 he became showroom manager of the Stretford and District Electricity Board, and in 1945 was appointed technical sales engineer in the North of England and North Wales for a heating company. He joined the Board's Oldham District in 1953.

Mr. H. F. Wickham has been appointed deputy secretary of the Electrical Industries Benevolent Association and will take up his duties on 8th October at its headquarters at 10, Buckingham Palace Gardens, S.W.1. Mr. Wickham is the son of a wholesaler, and his career has been in the wholesale distribution side of industry. After service in the Royal Navy he returned to the staff of Simpson, Baker & Co., Ltd., electrical wholesalers. He joined the Electrical Wholesalers' Federation in 1948, was appointed its secretary in November, 1952, and has been associated with *The Electrical Wholesaler* since its first issue in 1949, becoming its editor in 1953. He is a founder member of the Electrical Industries Club and has been its social secretary since its inception. He was recently elected hon. treasurer of the Federation of Wholesale Organisations.



Mr. H. F. Wickham

The Minister of Fuel and Power has appointed **Mr. E. C. Willis,** F.C.I.S., Companion I.E.E., of Bristol, to be deputy chairman of the South Western Electricity Board in succession to **Mr. H. Midgley,** M.Sc.(Eng.), M.I.C.E., M.I.E.E., whose retirement on medical grounds on 31st May we have already reported. **Col. T. F. Hood,** O.B.E., T.D., D.L., J.P., F.C.A., of Newton St. Loe, near Bath, has been appointed as a part-time member of the Board.



Mr. E. C. Willis

Mr. Willis was educated at the Merchant Venturers' Technical College and joined the Bristol Corporation Electricity Department in 1919. He was appointed secretary to the general manager in 1929, and to the Electricity Committee in 1933, and in 1945 was appointed secretary and sales manager of the Bristol undertaking. Later in the same year he became general manager of the undertaking. On nationalisation he was appointed manager of the Bristol Sub-Area of the South Western Electricity Board, a position he now leaves to take up his new appointment.

Two new appointments are announced by the Marconi International Marine Communication Co., Ltd., with the creation of separate

Mr. W. Maconachie

Mr. L. A. Hooper

publicity and technical information departments following a reorganisation of the previous technical information and publicity division. **Mr. W. Maconachie,** now appointed publicity manager, will be responsible for all publicity and advertising matters, while **Mr. L. A. Hooper** becomes manager, Technical Information Department, and will deal with the production of instruction manuals and other technical literature.

Mr. Maconachie entered the service of the Marconi International Marine Communication Co., Ltd., as a seagoing radio officer on the outbreak of the war and in 1948 was appointed to the company's shore staff as an assistant in the publicity department. He became assistant manager of the technical information and publicity division in 1951.

Mr. Hooper joined the Marconi Sounding Device Co., Ltd., at Barnes in 1931, and later transferred to Marconi's Wireless Telegraph Co., Ltd., at Chelmsford, where he was in charge of the echosounding test section. In 1936 he entered the service of the Marconi International Marine Communication Co., Ltd., for special duties connected with the installation of echometer equipment on board ships in ports in the United Kingdom and on the Continent. He joined the technical information section of the company's technical division in 1940, and in 1951 was promoted to assistant manager on the formation of the technical information and publicity division.

The South of Scotland Electricity Board has appointed **Mr. H. C. Thompson,** B.Sc.(Hons.), A.R.T.C., M.I.E.E., as area engineer, Clyde Area, in succession to **Mr. W. H. George,** who is retiring on 31st August. After service with the Metropolitan-Vickers Electrical Co., Ltd., and the Clyde Valley Electrical Power Co., Mr. Thompson was appointed senior assistant engineer (planning and development) in the Clyde Area in 1948. He later became senior assistant engineer (technical) and in 1951 he was appointed deputy area engineer, Clyde Area.

The London Electricity Board has appointed **Mr. P. A. Lingard,** B.Com., at present an assistant chief commercial engineer, to the position of deputy chief commercial officer with effect from 1st August. Mr Lingard was educated at Berkhamsted School and London University and in 1936 he joined the staff of the County of London Electric Supply Co., Ltd. Between 1939 and 1946 he served in the Royal Artillery. In 1947 he was appointed area manager of the Lambeth and Camberwell area, County of London Co. and associated companies, and on the nationalisation of the industry he was appointed commercial officer, South Western Sub-Area, London Electricity Board. Since 1953 he has held the position of assistant chief commercial engineer.

Mr. A. G. Galle, A.M.I.E.E., M.I.W., the author of "Automatic Resistance Welding" published in this issue, received his technical training at the Manchester College of Technology and served his apprenticeship with the Metropolitan - Vickers Electrical Co., Ltd. Later he spent three years with Standard Telephones & Cables, Ltd., working on plant layout, and a further three years with the English Electric Co., Ltd., Stafford, on transformer development. Mr. Galle then became chief electrical engineer with the British Federal Welder Co., Ltd., Dudley, where he remained for fifteen years. For the past eight years he has been with Sciaky Electric Welding Machines, Ltd., as Midland technical representative and applications engineer.

Mr. A. G. Galle

Mr. G. M. Menzies was recently elected chairman of the British Steel Founders Association in succession to **Mr. F. N. Lloyd.** Mr. Menzies is chairman and managing director of the North British Steel Foundry, Ltd., and a director of other companies.

Mr. W. A. Brecknell, whose article on "Industrial Power Factor Correction" appears in this issue, was educated at Birkenhead Institute and Birkenhead and Liverpool Technical Colleges. In 1932 he joined British Insulated Cables, Ltd., spending five years at the company's Prescot Works before going to the Liverpool sales office. During his six years' wartime service with the Royal Engineers his duties involved electrical power distribution at home and overseas, and included work on the Mulberry Harbour project and power station work in Europe. In 1945 B.I. Cables amalgamated with Callender's and Mr. Brecknell, on demobilisation, spent several months in the Capacitor Department of the B.I.C.C. works at Helsby. In 1946 he became sales engineer at the Leeds sales office of the company, being engaged mainly on power factor correction schemes in the North-East, and in June last year he was transferred to his present post in the Capacitor Sales Department at Helsby.

Mr. W. A. Brecknell

Mr. H. W. Carter, T.D., formerly senior assistant secretary of the South Wales Division, Central Electricity Authority, has been appointed secretary of that Division in succession to **Mr. E. J. Turner,** who was recently appointed assistant secretary (committees and general administration) at the Authority's headquarters in London. Mr. Carter was educated at Cardiff High School and in 1927 entered the Town Clerk's Department of the Cardiff City Council where he held various administrative and legal appointments. He was later articled to Mr. S. Tapper-Jones, LL.B., Town Clerk of Cardiff, and was admitted a solicitor in 1949. He served in the last war in the 6th Battalion the Welch Regiment (67th S.L.R.) and in the Royal Artillery, being demobilised with the rank of major. In 1949 he joined the South Wales Electricity Board as a sub-area administrative and legal officer at the Central Sub-

Area headquarters, leaving there in 1951 on his appointment as senior assistant secretary to the South Wales Division. Mr. Carter is a member of the Law Society, London, the Cardiff and District Law Society, and the Royal Institute of Public Administration. He is the hon. secretary of the Cardiff Branch of the Institute of Industrial Administration and the hon. treasurer of the South Wales Group of the Royal Institute of Public Administration.

Lion Electronic Developments, Ltd., has appointed **Mr. L. E. Moore** as sales manager for both the electronics division (development and production) and the Leocast division (resin encapsulation techniques). Mr. Moore was previously in charge of technical liaison with the company.

Mr. L. E. Moore

Simon-Carves, Ltd., announce that the following have been appointed technical directors: **Mr. K. MacGregor** (Coke Oven Department); **Mr. J. E. Chick** (Washery Department); **Mr. L. Brook** (Power Plant Department); **Mr. A. E. Taylor** (Chemical Plant Department); and **Mr. O. J. H. Simon** (Chemical Plant Department).

Mr. W. A. Coates, M.I.E.E., F.Amer.I.E.E., retired from the board of the Metropolitan-Vickers Electrical Co., Ltd., on 4th July. He will continue as commercial consultant to the managing director until the end of the year. Mr. Coates has been with companies of the A.E.I. Group for fifty years. He joined M-V (then British Westinghouse) in 1909 and was successively chief engineer (1918), consulting engineer, and sales manager in the Switchgear Department before becoming manager, home sales, in 1946. In 1948 he was appointed to the board, and from 1952 till early last year he was general sales manager. Mr. Coates has also resigned from the boards of the subsidiary companies, Metropolitan-Vickers - GRS, Ltd., Newton Victor, Ltd., and Sunvic Controls, Ltd.

Electric & Musical Industries, Ltd., announce that **Mr. G. E. Condliffe** has, as from 1st July, relinquished his position of managing director of E.M.I. Research Laboratories, Ltd., to take over the post of research and technical consultant to the chairman and the managing director of Electric & Musical Industries, Ltd.

The result of the annual competition for the W. E. Highfield Shield, which was presented by the late Mr. W. E. Highfield when president of the Association of Supervising Electrical Engineers for competition among members, has now been announced by the Executive Council. The adjudicators in the competition, consisting of Mr. Bryan Donkin, the president of the Association, Mr. H. E. J. Butler, national chairman, and Mr. J. H. K. Pendry, chairman of the Technical Committee, awarded the Shield and the first cash prize of £10 10s to **Mr. G. V. McNeill,** of Forest Hill, London, for his paper "Industrial Lighting Economics." Second cash prize of £5 5s was awarded to **Mr. E. Copeland,** of Enfield, Middlesex, for his paper entitled "Flameproof Electrical Installations and Equipment." **Mr. W. T. Partington,** of Chester, has been awarded the third prize of £3 3s for his paper "Are You a Good Supervisor?" The awards will be made by the president of the Association at the opening meeting of the London national lecture programme at the Institution of Electrical Engineers on 16th October.

Mr. V. C. H. Creer, of the British Thomson-Houston Co., Ltd., has resigned from the Electrical Fair Trading Council and **Mr. A. E. Page,** of the General Electric Co., Ltd., has been appointed to the Council.

Miss Marjorie Bailey, B.Sc., head of the E.A.W. Housecraft Department, was married to Mr. Ivor Pickford at the Church of the Ascension, Balham Hill, on 7th July. Mrs. Pickford will continue her work with the Association.

Mr. A. A. H. Douglas is relinquishing his appointment as director and general manager of the Distington Engineering Co., Ltd., a subsidiary company of the United Steel Companies, Ltd., at his own request, and **Mr. G. N. F. Wingate,** at present works manager (services) with Steel Peech & Tozer, a branch of the United Steel Companies, will succeed him from 1st August.

Mr. E. F. L. Brech, management consultant and a senior partner of Urwick, Orr & Partners, Ltd., has been awarded the Bowie Medal for 1955 by the Institute of Industrial Administration. The medal is awarded annually to a member of the Institute for a noteworthy contribution to management.

Mr. P. J. Walsh has been appointed regional manager for Eire for Remington Rand, Ltd.

Mr. Harry L. Ranson, M.S.M.A., A.M.Brit.I.R.E., formerly general sales manager of the Furzehill Group, has been appointed general sales manager of Atkins, Robertson & Whiteford, Ltd.

Mr. Richard Hawton-Hill, a foreman in one of the Moulding Departments of Litholite Insulators & St. Albans Mouldings, Ltd., has completed fifty years' service with the company. He has been presented with a cheque by the directors.

Despite bad weather conditions, the annual sports of **E. K. Cole, Ltd.,** held at the company's Southend-on-Sea sports ground on 14th July were a success. The programme, which included club and open events, as well as an Essex County ladies' relay, was completed in its entirety. After Mr. E. K. Cole, chairman and managing director of E. K. Cole, Ltd., had addressed the competitors and spectators, Mrs. E. K. Cole presented the trophies and prizes. The inter-departmental shield was won by the Southend Offices, a team representing the Ekco Malmesbury Works taking second place.

The annual **Ekco v. Plessey** athletic match was held at the Southend-on-Sea Sports Ground of E. K. Cole, Ltd., on 18th July. The match ended in a draw, each team scoring 77 points.

OBITUARY

Major D. Goad, O.B.E., M.I.E.E., formerly chief mechanical and electrical engineer, Air Ministry Directorate of Works, died on 7th July at the age of seventy-six. Major Goad, who received his technical education at the Regent Street and Northampton Polytechnics, served as an apprentice with Drake & Gorham, Ltd., from 1896 to 1899, and then joined the firm of A. V. Gifkins & Co., consulting engineers, as an engineer and was appointed a director in 1914. During his service he was responsible for large electrification schemes, many overseas, and acted on behalf of the company on such schemes in India from 1913 to 1917. In the last-mentioned year he was commissioned as a lieutenant in the R.N.V.R. and served in the Air Service Construction Branch of the Royal Naval Air Service. In 1918 he transferred to the R.A.F. with the rank of major and was awarded the O.B.E. in 1919. He became a superintending civil engineer in the newly formed Air Ministry Directorate of Works and Buildings in 1920 and in 1928 was appointed chief mechanical and electrical engineer; he retired in 1942, but his services were retained by the Air Ministry in a consultative capacity until 1945.

Mr. Sydney Warren, of Linthorpe, Middlesbrough, managing director of Erimus Electrical Factors, Ltd., Middlesbrough, has died at the age of eighty-two. Mr. Warren started his career with a Middlesex firm of electrical manufacturing engineers and later became a director of Warren, Beattie & Co. He started the firm of Erimus Electrical Factors, Ltd., twenty-three years ago.

Miss Ethel Green.—The Electrical Association for Women announces the sudden death on 13th July of Miss Ethel Green, E.A.W. organiser in the North-Eastern Area since 1947. Miss Green was appointed secretary of the Sunderland Branch of the Association on its formation in 1936.

VIEWS on the NEWS

By REFLECTOR

HAVING just had an opportunity of reading a full account of Lord Citrine's speech at the Duke of Edinburgh's Study Conference at Oxford which caused something of a stir I must say that I found it very well-reasoned and logical. He showed that while competition had promoted the growth of British industry there was a point where the interest of nobody was being served by carrying competition further. It followed, he said, that people who had some kind of common interest were wise in getting together in an association, however loosely formed, for the purpose of seeing how far they could agree on certain things. But he emphasised that he was always speaking "with the reservation that no deleterious effect to the public interest is involved in this kind of association." On price agreements, Lord Citrine said he did not want it to be assumed that he regarded them as *necessarily* wrong and went on to explain this point:—

> "I think that just as the trade unionist combines to prevent his standard of life, in other words his wages, being driven down by competition among the individual members, so it seems to me to be quite justifiable that among firms, some kind of consultation should take place which will avoid the standards at which they can sell their commodities being debased. And I tell you why. I do not believe that trade unions can maintain the standard of life of their members in an era when competition is carried to the point that the price is being driven down below the economically justifiable level."

It was with this human side, which after all was the theme of the conference, that Lord Citrine was mainly concerned and on which he expressed forthright views. He criticised the type of industrial welfare which was organised solely for the purpose of enabling people to produce efficiently, saying that it was bound to fail because it was so partial. They had to convince people that they were interested in them not merely as producers but as human beings.

* * *

I have just seen some particulars of a Fire Protection Centre which is to be opened in Glasgow on 5th November. I don't know whether there is any significance in the choice of the opening date. From a perusal of the literature giving particulars of the fittings, devices and systems for fire prevention which are to be displayed, the Centre should fulfil a useful service, but I suspect a number of fires will be started on the opening date for which the services offered and the equipment on show at the Centre will not be required.

* * *

What the advocates of "co-ordination" have so far been unable to force upon the gas and electricity supply industries is now coming about by reason of financial restrictions. In a letter to the *Sunday Express* an elderly lady says that she has just acquired a small cottage in Salisbury and has asked the Southern Electricity Board for a supply of electricity, which has been refused because there is already a gas supply. The Board explains that normally the presence of gas in the house would make no difference but because of the Government's limitation upon capital expenditure it has to "draw the line somewhere." It is not the Board's fault that it has to adopt this policy. The strange thing is that one can still see many examples of less essential expenditure wherever one goes: the proliferation of Government buildings, for instance.

* * *

An effect which often puzzles people is the discoloration which appears behind an electric fire, around the ceiling light, and on the wall above the television set. As electricity is fumeless, what causes these dark patches? This matter was commented upon in the *Electrical Review* as long as seventy years ago (30th July, 1886) in a note entitled "A Curious Effect" which offered the following explanation:—

> "The general belief that an incandescent lamp is absolutely innocuous as regards its power of blackening ceilings has, in one case at least, been proved to be not absolutely correct; we recently had shown to us a case in which one of these lamps was placed at a distance of about 18 inches from a whitewashed ceiling, and directly over the lamp a circular space of about the diameter of the glass bulb had become blackened as though by the action of smoke. This result no doubt is due to the heated current of air set up by the lamp carrying with it particles of dust continually against the ceiling."

* * *

According to the *Evening Standard*:—

> "Clerical staffs in London's council offices now find it useful to have a knowledge of electricity and an understanding of machines, for automation and mechanisation are taking over an increasing share of the work."

All the same I think the time is still some way off when advertisements for engineer-typists or shorthand-electricians will be seen in the Press.

* * *

From another report in the *Evening Standard* it seems that schoolteachers in Kent have been dabbling in installation work. Following discoveries of dangerous wiring and equipment for which "do-it-yourself" enthusiasts among these teachers have apparently been responsible, the county's chief education officer has issued an instruction that such things should not be.

> "It cannot be too strongly emphasised that the standard mains voltage can be lethal. Portable equipment must be connected to suitable plugs, and not light sockets, by a single length of cable without joints."

There is also a warning against "enlarging" fuses to counteract persistent blowing; an electrician should be sent for instead. Teachers should really know better than to give such bad examples to their children and it is to be hoped that the warnings will be heeded.

Financial Section

STOCKS and SHARES

A TURN for the better in leading electrical equipment shares during the past week was credited in part to the latest news concerning the nuclear power programme. Reports that the twelve atomic power stations to be constructed by 1965 are to have a capacity about double that originally planned revived investment interest in the shares of the firms known to be closely concerned. Industrials generally recovered some ground, although still tending, of course, to be swayed by the course of developments in the labour situation, and lacking encouragement from a persistently dull gilt-edged market.

Ekco Meeting

At the E. K. Cole annual meeting the chairman found it difficult to forecast the current year's prospects for the radio industry which, he said, continued to account for a substantial part of the group's turnover. Sales of radio and television sets had been affected by the Government's financial measures. Encouraging signs of improvement had, however, been noticed lately. He expected a satisfactory return from this side of the business, although the profit might be reduced and economic developments could substantially affect the results one way or the other. In the year ended last March the net profit of the group, after tax, was moderately higher than before, and the 17½ per cent dividend came from earnings equivalent to 64 per cent on the ordinary capital. The 5s shares at 17s 3d offer a yield of a little over 5 per cent.

Firmer Market

English Electrics, with a rise of half-a-crown, were well to the fore in the revival of electrical equipment share prices, and General Electrics were firm in advance of the final dividend declaration. Official quotations for Parsons and Reyrolles were marked up 5s apiece, and in the market the shares have been changing hands at prices not very much short of this year's highest marks of 88s 6d and 111s. Another remarkable performance by British Aluminiums took the price up a further 10s, to 77s 6d, before a reaction to 75s occurred: buying from across the Atlantic was said previously to have remained aggressive. Murex were raised 1s 9d, to 70s, on the strength of the good results; the dividend for the year is brought up to 20 per cent, the same total as for last year, when 5 per cent of the distribution was paid as a bonus. Hackbridge Cable were 1s to the good at 23s 9d on news of the increase in the dividend from a total of 25 to 30 per cent, which brings the yield on the shares to over 6½ per cent.

Many Improvements

Crompton Parkinson picked up well to 13s 9d, attention being called to the

Price Changes in

Company or Board	Nom. Value	Middle price 23rd July	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1956 Highest	1956 Lowest
Gilt-edged Stocks								
Brit. Elec. 1968/73	100	75½		3	3	3 19 6	80½	74½
Brit. Elec. 1974/77	100	73½		—	3	4 1 9	79⅛	73⅜
Brit. Elec. 1976/79	100	77½		3½	3½	4 10 3	84	77½
Brit. Elec. 1974/79	100	88½		4¼	4¼	4 16 0	95	88
Overseas Electric Supply								
Calcutta Elec.	£1	19/6		6†	6†	6 3 0	20/9	19/-
East African Power	£1	19/-		7	7	7 7 3	21/3	19/6
Nigerian Elec.	£1	18/-	−6d	10	10	11 2 0	21/-	17/-
Palestine Elec. "A"	£1	21/-		Nil	Nil	Nil	21/-	21/-
Perak Hydro-Elec.	£1	16/-		10	10	—	17/6	14/9
Equipment and Manufacturing								
Aberdare Cables	5/-	11/6	+6d	17½	17½	7 12 3	13/6	10/6
Aerialite	1/-	4/9	+3d	88½	45*	9 9 6	6/9	4/9
Allen, W. H.	£1	36/3x.d.		20	10*	5 10 3	39/-	33/6
Aron Elec. Ord.	£1	55/9		15	15	5 7 6	56/-	53/6
Assd. Automation	10/-	18/-	+1/-	10	5	2 15 6	—	17/-
Assoc. Elec. Ord.	£1	68/9		14	15	4 7 3	85/6	57/9
Automatic Tel. & El.	£1	56/3		15	15	5 6 9	72/6	56/3
Babcock & Wilcox	£1	75/6	+2/-	15	15	3 19 6	85/6	64/-
Baldwin, H. J.	2/-	5/-		20	20	8 0 0	5/-	3/9
Bakelite	10/-	28/-	+6d	16	16	5 14 3	34/-	26/9
Berry's Electric	5/-	6/6		—	10‡	7 13 9	6/6	5/9
British Aluminium	£1	75/-	+7/6	12	12	3 4 0	77/6	40/6
B.I. Callender's	£1	51/6	+1/-	10	12½	4 17 0	54/3	45/-
B.I. Callender's 6% Pref.	£1	21/-	+6d	6	6	5 14 3	22/6	20/3
British Thermostat	5/-	25/-		20	25	5 0 0	31/9	24/6
British Vac. Cleaner	5/-	6/3	+3d	30	15*	12 0 0	8/9	6/-
Brook Motors	10/-	36/3		20	25	6 18 0	44/-	36/3
Brush Ord.	5/-	5/9		10	10	8 14 0	7/9	5/9
Bulgin, A. F.	1/-	4/9		45	50	—	5/3	4/3
Burco Dean	5/-	8/6		—	22½	13 4 9	13/3	8/6
Chloride El. Storage "A"	£1	62/6		17½	17½	5 12 0	73/6	60/9
Clarke Chapman	£1	105/-		20	22½	4 5 9	112/6	89/6
Cole, E. K.	5/-	17/3	+1/9	17½	17½	5 1 6	22/3	15/6
Cossor, A. C.	5/-	7/-	+3d	10	15	10 14 3	10/3	6/9
Crabtree	10/-	27/-		20	20	7 8 3	29/3	27/-
Crompton Parkinson Ord.	5/-	13/3	+9d	20	16*	6 0 9	15/-	12/3
De La Rue	5/-	17/6	+3d	30	30	8 11 6	20/3	15/-
Decca	4/-	27/6		56½	43¾*	6 7 3	44/9	24/9
Desoutter	5/-	30/6		25	30	4 18 3	32/9	25/9
Dewhurst	2/-	6/6		24	30	—	7/6	5/3
Dictograph Tel.	2/-	5/9		20	20	6 19 3	6/9	5/9
Dubilier Condenser	1/-	4/3	+6d	25	25*	5 17 9	4/9	3/6
E.M.I.	10/-	28/3	+1/9	10	15	5 6 3	37/-	26/3
Electrical Components	5/-	12/6		20	25	10 0 0	16/-	12/6
Elec. Construction	£1	26/3		8½	8½	6 9 6	29/9	25/-
Enfield Cable Ord.	£1	14/9	+3d	Nil	Nil	Nil	19/3	13/6
English Electric	£1	53/9	+2/6	12½	12½	4 13 0	66/3	47/3
English Electric 3¾% Pref.	£1	13/-		3¾	3¾	5 15 6	14/6	12/6
Ericsson Tel.	5/-	35/6		20†	20†	2 16 3†	42/9	33/6
Ever Ready	5/-	27/3	+6d	35	35	6 8 6	32/9	24/-
Falk Stadelmann	£1	36/3		15	17½	9 13 0	45/9	36/9
G.E.C. Ord.	£1	58/9	+2/6	12½	14	4 15 3	65/6	50/-
G.E.C. 6½% Pref.	£1	22/6		6½	6½	5 15 6	23/9	21/3
General Cables	5/-	11/3		30	30	13 6 9	13/9	11/3
Greenwood & Batley	£1	46/3		17½	17½	7 11 3	47/6	45/-
Hackbridge Cable	5/-	23/9	+1/-	25	30	6 6 3	24/6	18/9
Hackbridge & Hewittic	5/-	18/3		30	23*	6 6 0	22/-	17/3
Heatrae	2/-	3/9		15	15	8 0 0	5/1	3/9
Henley's	10/-	16/3	+6d	10½	11½	7 1 6	99/9	14/-
Holophane	5/-	20/3	+6d	25	30	7 8 3	20/3	17/-

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.
* After scrip issue. † Free of income tax. ‡ Dividend forecast.

attractions of a 6 per cent yield from the shares. There was an all-round improvement in cable manufacturing shares under the lead of B.I.C.C., which gained 1s to 51s 6d. Tube Investments, I.C.I. and Babcocks rose well, and Ward & Goldstone put on 2s 6d for the second week in succession. Brook Motors were called 34s 9d in the market after the news of the coming "rights" offer of shares at 30s. Plesseys recovered 1s 6d to 70s, and radio shares generally threw off some of their recent depression, E.M.I. rising by 1s 9d, Pye by 2s and E. K. Cole by 1s 9d. Improvement in this group was credited mainly to the review of conditions by the chairman of the last-named company at the annual meeting.

Electrical Investments

Company or Board	Nom. Value	Middle price 23rd July	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1956 Highest	1956 Lowest
Equipment and Manufacturing—continued								
Hoover	5/-	25/-		70	50	10 0 0	39/3	23/-
I.C.I.	£1	46/3	+1/6	10	10	4 6 6	49/9	41/3
Intl. Combustion	5/-	18/6		25	20*	5 8 0	25/-	15/3
Johnson & Phillips	£1	41/3	+6d	15	15	7 5 6	46/6	37/6
Lancashire Dynamo	£1	42/6		15	11*	5 3 6	49/9	40/9
Laurence, Scott	5/-	15/3		12½	15	4 18 3	16/9	13/3
Lister, R. A.	£1	30/-		9·3	10	6 13 3	35/3	27/6
London Elec. Wire	£1	50/-		12½	12½	5 0 0	52/9	46/5
Lucas, J.	£1	30/3	+9d	7½	7½	4 19 3	40/3	29/6
Marryat & Scott	2/-	11/-x.d.		30	30	5 9 0	11/3	9/6
Mather & Platt	£1	52/6	+1/-	15	15	5 14 3	65/3	51/6
Metal Industries	£1	19/-	+1/-	9	9	—	27/-	16/3
Midland Elec. Mfg.	£1	45/-		10	12½	5 11 0	48/6	43/6
Morphy-Richards	4/-	20/-		35	50	10 0 0	27/3	20/-
Murex	£1	70/-	+1/9	20	20	5 14 3	70/3	60/-
Newman Ind.	2/-	2/3		10	10	8 17 9	2/9	2/1
Oldham & Son	1/-	2/3x.d.		20	17½*	7 15 6	3/-	2/3
Parnall (Yate)	5/-	5/9		14	12	10 8 9	9/6	5/6
Parsons, C. A.	£1	85/-	+5/-	10	10	2 7 0	88/6	61/6
Plessey	10/-	70/-	+1/6	27½	30†	4 5 9	87/6	56/-
Pye "A" Deferred	5/-	18/3	+2/-	20	12½*	3 8 6	21/3	14/-
Revo	10/-	14/3		9	9	6 6 3	14/6	8/3
Reyrolle	£1	105/-	+5/-	15	16½	3 2 0	111/-	81/-
Rheostatic	4/-	9/6		18½	12†	5 1 0	—	8/3
Richardsons Westgarth	5/-	15/6		16⅔	16⅔	5 7 6	17/-	13/9
Scottish Cables	4/-	16/3		27½	27½	6 15 3	17/9	15/9
Smith (England), S.	4/-	10/6		17½	17½	6 13 3	14/3	10/6
Southern Areas	£1	16/3	−1/3	10	7½	9 4 6	28/9	16/3
Strand Elec.	5/-	6/9	−6d	17½	15*	11 2 3	8/6	6/9
Sturtevant	5/-	22/9	+3d	14·4†	15†	3 6 0†	31/3	22/6
Sun Elec.	£1	35/-x.d.		15	20	11 8 9	37/6	35/-
Switchgear & Cowans	5/-	13/9		20	25	9 1 9	17/-	13/6
Taylor Tunnicliff	5/-	11/9	−6d	15	15	6 7 9	14/-	11/3
T.C.C.	10/-	43/-		25	25	5 16 3	45/-	40/6
T.C. & M.	£1	28		8½	8½	6 1 6	34/-	26/-
Telephone Mfg.	5/-	7/-		10	10*	7 2 9	8/6	6/3
Thorn Elec.	5/-	17/6		20	15*	4 5 9	22/6	16/-
Thornycroft	£1	42/6		15	15*	7 1 3	49/9	41/3
Tube Investments	£1	58/9	+3/9	22½	14*‡	4 15 3	70/6	54/9
Vactric	5/-	13/9	+1/3	15	17½*	6 7 3	15/-	11/6
Veritys	5/-	8/-		12½	12½	7 16 3	10/-	6/9
Walsall Conduits	4/-	13/3	+6d	70	20*	6 0 9	13/6	10/9
Ward & Goldstone	5/-	38/9	+2/6	30	35	4 10 3	38/9	29/-
Watford	2/-	6/3		25	25	8 0 0	7/6	6/3
Westinghouse	£1	72/6		18	18	4 19 3	100/-	71/6
West, Allen	5/-	12/3		15	15	6 2 6	14/6	11/6
Wolf Electric	5/-	17/6		20	20	5 14 3	26/3	17/6
Trusts, Transport and Communications								
Anglo-Am. Tel.:								
A. Ord.	100	74	−1	6	6	8 2 3	80	66
Ord.	100	47½		3¾	3¾	7 18 0	54	45
Anglo-Portuguese	£1	23/-		8	8	6 19 3	23/6	20/3
Brit. Elec. Traction:								
Def. Ord. "A"	5/-	16/6		22½	22½	6 16 3	20/-	15/6
Cable & Wireless:								
Ord.	5/-	10/3		10	10	4 17 6	11/3	9/6
4% Loan	100	90½		4	4	4 8 6	92½	88
Calcutta Trams	£1	24/-		6†	7½†	6 5 0†	26/3	23/-
Cape Elec. Trams	£1	18/3		5½	7½	8 4 6	20/3	18/-
Marconi Marine	£1	31/6		10	10	6 7 0	34/-	31/-
Oriental Tel. Otd.	1/-	73/9	−1/3	16	—	—	90/-	67/6
Telephone Rentals	5/-	11/-	+3d	12½	12½	5 13 9	11/9	9/9

J. & P. Loan Stock

A yield of 5·9 per cent can be obtained from the new Johnson & Phillips 5¾ per cent unsecured loan stock, which stands about half a point above the issue price of 97 and has at present the material advantage of being transferable free of the usual 2 per cent stamp duty. It is now fully paid and will remain free of transfer stamp until the beginning of August. The stock is redeemable at par finally in 1976, with the company's option to repay from 1971 onwards. The principal amount of this £1·8 million issue is covered four times by the net assets of the group, and the annual interest charge some five and a half times by average profits of the past five years. Dividends are payable at end-March and September, with an initial payment of 32s 3d per cent next September.

Trust Dividends

Cable and Wireless (Holding) announce a second quarterly interim dividend of 1¼d per share and a further increase in earnings over the latest three months. This brings the total for the first half of the year to £240,000 net, or £40,000 more than in the corresponding six months of last year. On the basis of a 10 per cent dividend for the year, the 5s shares at 10s 3d yield 4·9 per cent. The 5s shares of Globe Telegraph & Trust, another of the companies under the chairmanship of Sir Edward Wilshaw, stand at about the same figure, and the final dividend just declared also makes a total of 10 per cent. Profits have expanded by a further 35 per cent to £479,000 net, and a rights issue of new shares at par is proposed.

Dividends Declared

Lodge Plugs 5s shares were called 12s 3d after the company's decision to maintain the dividend for 1955–56 at the previous rate of 25 per cent. Profits are little changed, and exceed by one and a half times the net amount of the dividend, on the basis of which the return on the shares is a fraction over 10 per cent. Negretti & Zambra 5s ordinary hardened to 15s on the announcement of an increase in the current year's interim dividend from 3 to 4 per cent, which is stated by the company to be justified by an advance in trading results for the first half of the period. Distributions for the last two years totalled 13 per cent, the latest of them being covered four times over by the net surplus available for dividends and reserves. Parmiter, Hope & Sugden's maintained dividend of 30 per cent comes from substantially higher earnings. The 1s shares are quoted at 2s 6d.

REPORTS and DIVIDENDS

E. K. Cole, Ltd.—The annual meeting was held on 19th July, Mr. E. K. Cole (chairman and managing director) presiding. In the course of his review of the past year's activities Mr. Cole said that they substantially increased their turnover during the year. Dealing with the various divisions, he said that the trading conditions of the radio industry over the past year on the whole remained at a satisfactory level. Their new television, radio and car radio models had been well received, and the radio division established a new record in turnover. The subsidiary company, Ekco Electronics, Ltd., had made further progress in the development and sale of electronic equipment; over two-thirds of the turnover being exported. The plastics division increased its turnover to a new high record during the year and although the margins of profit were lower an overall satisfactory result was achieved. The heating division increased its turnover by approximately one-third and the profit position improved considerably.

The export turnover of the group was maintained during the year, though trading conditions in the domestic radio field overseas remained difficult. The tendency for other countries to become self-supporting in the field of light engineering continued and they had taken further steps to participate in schemes to provide assembly of their products overseas. A major project undertaken was the agreement with Associated Electrical Industries, Ltd., to form the jointly owned company in Australia named Ediswan-Ekco (Aust.) Pty., Ltd., with an authorised capital of £A1,000,000, to undertake the manufacture of television and radio receivers, and cathode ray tubes.

John Thompson, Ltd.—The annual meeting was held on 18th July. In his circulated review of the past year's activities, Mr. E. W. Thompson (chairman and managing director) said that almost without exception production by the various group companies had increased. Orders on hand at the end of the year were maintained at practically the same figure as at the end of the previous year in spite of the increased output. The companies in Australia, India and South Africa had all made satisfactory progress. Referring to the formation of the A.E.I. - John Thompson Nuclear Energy Co., Ltd., in which John Thompson, Ltd., has one-third interest, the chairman said that this company was now engaged in completing designs and preparing a tender to be submitted to the Central Electricity Authority. Nuclear power stations of this type were large projects of the order of £15-20 million. The company was also engaged on the construction of the first private research reactor of 5 MW (heat) output to the order of the A.E.I. Group Central Research Establishment at Aldermaston. With regard to the contract for the A.E.A. fast reactor at Dounreay, the central stainless steel vessel, primary heat exchangers and ancillary equipment were now in an advanced stage of construction in the works and would shortly be ready for erection inside the large sphere at Dounreay.

Their new research laboratory was now completed and was already proving its value. With rising costs and keener competition, it was difficult to make a statement regarding future prospects. The output of the home group companies, however, for the first three months of 1956 had shown a satisfactory increase. Orders on hand for the manufacturing companies also showed a considerable increase at the same date, but this was almost exactly offset by a reduction in orders for their long-term contracting business. In general, up to the present orders were keeping in line with output.

The output for direct exports was somewhat reduced as compared with 1954, but this, to a large extent, was due to the increase in local manufacture abroad. The Australian company had just secured an extension to the existing power station contract at Wallerawang, New South Wales, the approximate value of this extension being £2½ million. The total of direct and indirect exports together with the output of overseas companies represented nearly 50 per cent of the whole group production.

Venner, Ltd.—The report and accounts now issued confirm the preliminary figures given in our issue of 6th July. In his accompanying statement, Mr. A. A. Rowse (chairman) says that labour costs have risen and competition has become keener, but by attention to methods of manufacture and plant utilisation, coupled with an increased output, the position has been more than held. Referring to their various products, the chairman says that the battery is establishing itself in its own special field and the business likely to be available in the near future is such that additional factory space will be needed and active steps are being taken by the board. On the precision engineering side there is a wide commercial field and although some development work remains to be completed the long-term prospects are encouraging. With regard to the parking meter, nearly all the meters installed in the Commonwealth have been made by them and the freedom from trouble in service confirms the view that the manufacturing facilities which have been created will constitute a remunerative asset in due course when the Transport Bill has passed the House of Lords.

The rise in the interest rate on municipal borrowing and the call for economy may dissuade some Councils from expenditure on new projects. However, so much of the output of the company in this field is essential to normal development that the long-term effect is unlikely to be serious, although, once again, current trading may be affected in some measure.

Reliance-Clifton Cables & Industrial Products, Ltd.—In reviewing the company's activities during 1955 at the annual meeting held on 20th July, Mr. H. Davis (who presided in the absence of the chairman, Sir Robert Renwick, Bt.) said that the considerable improvement in demand reported last year continued for the remainder of the year. A less satisfactory feature was the continued instability of the prices of raw materials and particularly of copper. All materials were, however, in free supply and there was an easement of the labour shortage. In these favourable conditions they were able to exceed the previous sales record which had been set up in 1952. In March last a peak price of £437 per ton for copper was quoted on the London Metal Exchange; by 3rd July it had fallen to £264 and was now relatively steady at around £290 per ton. It was to be hoped that in the early future they would have a reasonably stable price for their principal raw material.

In their main field of activity, the supply of telecommunication wires and cables, demand had continued at a satisfactory level, although somewhat below what might have been anticipated from the initial scale of ordering by the Post Office, when work commenced on its current plan for the expansion of the telephone service. While there had been some running down of the order book, they continued to be well occupied and sales for the first six months were in excess of the corresponding period of last year.

The British Thermostat Co., Ltd.—Increased turnover in both home and export markets during 1955 is reported by Mr. J. E. Sherlock (chairman and managing director) in his review of the past year. The "credit squeeze" has not yet had any serious effect upon trading but it is inevitable that it will result in some recession. The method of group operation has been proved worth while and during the year the group has been enlarged by the addition of two new companies, P. W. Baker & Sons (Sales), Ltd., and Teddington (Holland) N.V. It is hoped that the negotiations for the formation of the Australian company, referred to in the previous review, will be completed shortly, and that operations will commence within the next twelve months.

Murex, Ltd.—The group profits for the year ended 30th April last, before setting aside £666,000 for taxation, were £1,245,000, as compared with £1,025,000 for 1954-55. Replacement

of fixed assets reserve receives £300,000, and it is proposed to pay a final ordinary dividend of 12½ per cent, making 20 per cent for the year. For the previous year the dividend was 20 per cent which included a bonus of 5 per cent. In addition a tax-free distribution of 10 per cent was made in that year from capital profits. The balance carried forward is £185,000 (against £170,000 brought in).

Ruston & Hornsby, Ltd., report a fall in trading profits for the year ended 31st March last from £1,716,041 to £1,565,208, and after meeting all charges, including £784,584 for taxation, the net profit is lower at £779,024 (against £1,060,753 for the preceding year). Despite the lower profit the distribution for the year on the ordinary capital is higher, 9 per cent being paid on ordinary capital increased to £6·15 million by a 50 per cent scrip issue. For the previous year 12½ per cent was paid on £4·1 million, equal to 8½ per cent on the present capital.

Walsall Conduits, Ltd.—The annual meeting was held on 16th July, Mr. A. E. Read (chairman) presiding. In his statement, which had been circulated with the report and accounts, the chairman said that output and sales had again reached record figures during the year under review and their products had been exported to sixty-two different countries. During the year they were working at full capacity within the limits of available labour and this also applied to the first five months of the current year. The demand for their products continued to expand both at home and abroad.

The Globe Telegraph & Trust, Ltd.—After providing £352,945 for taxation the net revenue for the year to 30th June is £478,730, as compared with £353,499 for the preceding year. General reserve receives £100,000 and it is proposed to pay a final dividend of 5⅝ per cent, again making 10 per cent for the year. The interim dividend of 3 per cent in the previous year was paid before a two-for-seven rights offer of £1 shares.

It is now proposed to make a rights issue at par of 4,000,000 5s shares at par, on a one-for-five basis.

The Cables Investment Trust, Ltd.—The profits for the year to 30th June last, after taxation of £276,829, are £374,623, as compared with £294,963 for 1954-55. The dividend for the year is maintained at 10 per cent by a final payment of 5⅝ per cent.

Parmiter, Hope & Sugden, Ltd., report that after providing £40,860 for taxation, the net profit for the year ended 31st March last is £29,426, as compared with £19,410 for the preceding year. The dividend for the year is maintained at 30 per cent by a final payment of 22½ per cent.

The East African Power & Lighting Co., Ltd., reports a profit for 1955, before taxation, of £603,595, as compared with £546,437 for 1954. East African taxation absorbs £51,420 and it is proposed to pay a final ordinary dividend of 4 per cent, again making 7 per cent for the year. The balance carried forward is £211,305 (against £179,858 brought in).

The Britannia Electric Lamp Works, Ltd.—The group profit for the year to 31st March last was £69,350, after taxation of £56,824, as compared with £61,515 for the preceding year, of which £66,466 is attributable to the holding company. The dividend for the year is maintained at 12½ per cent.

Hackbridge Cable Holdings, Ltd., proposes to pay a final dividend of 20 per cent (against 17½ per cent), making 30 per cent for the year (25 per cent).

The Sun Electrical Co., Ltd., is paying an unchanged interim dividend of 5 per cent.

R. B. Pullin & Co., Ltd., have declared an interim dividend of 5 per cent (unchanged).

Mather & Platt, Ltd., are paying an interim dividend of 4 per cent (unchanged).

New Companies

Southern Electronic Industries (Southend), Ltd.—Registered 10th April. Capital £2,000. To acquire the business carried on by Southern Electronic Industries at 485, London Road, Westcliff-on-Sea, Essex. Directors: F. C. Jolly and Mrs. Ethel M. Jolly.

Cray Electronics, Ltd.—Registered 13th April. Capital £5,000. V. W. Warner is the first director. Regd. office: 45, Meadow Road, Shortlands.

C. D. Hall (Electrical Contractors), Ltd.—Registered 20th April. Capital £2,000. To acquire the business of an electrical engineer and contractor carried on by C. D. Hall at Fishponds, Bristol, etc. Directors: C. D. Hall, Mrs. Kate Hall and R. Ludwell. Regd. office: 4, Alexandra Park, Fishponds, Bristol.

Leech & Hainge, Ltd.—Registered 2nd May. Capital £4,000. Manufacturers of and dealers in radio, electrical and mechanical apparatus, etc. Directors: P. J. Leech, J. W. A. Hainge, Z. B. M. Leech and B. D. Hainge. Regd. office: 6a, High Street, Chipping Norton, Oxon.

Koloflo Electric Signs, Ltd.—Registered 29th March. Capital £2,000. Directors: B. Lipton, J. Lipton and R. S. Smith. Regd. office: Queens House, Leicester Square, W.C.2.

Graham & Co. (Electrical), Ltd.—Registered 29th March. Capital £1,500. Electrical, radio, radar and television engineers, etc. Directors: J. B. Bristow, A. Graham, J. D. Coleyshaw and B. H. Taft. Regd. office: 33, Great Charles Street, Birmingham, 3.

Barclay Stuart (Electronics), Ltd.—Registered 3rd April. Capital £1,000. Electronic and automation engineers, etc. Directors: M. Goldman and Amy M. Goldman. Regd. office: 21-23, Brunswick Street, Luton.

Liquidations

Eagle Wireless Supply Co., Ltd., retail electrical dealers and traders.—Winding up voluntarily. Liquidator, Mr. J. A. Stancer, 9 and 11, Dormer Place, Leamington Spa, appointed 10th July.

E. & W. Smith (Electrical Engineers), Ltd., electrical engineers.—Winding up voluntarily. Liquidator, Mr. L. H. Shipton, Poppleton & Appleby, 31, Lloyd Street, Manchester, 2, appointed 9th July. Particulars of claims to the liquidator by 9th August.

Moffats Overseas, Ltd., dealers in electrical cooking apparatus.—Winding up voluntarily. Liquidator, Mr. G. L. Weiner, 31-45, Gresham Street, London, E.C.2, appointed 3rd July.

Maifod Electricity Co., Ltd.—Particulars of claims by 14th August to the liquidator, Mr. H. F. J. Cadwallader, Eagle House, Severn Street, Welshpool, Mont.

Bankruptcies

N. D. Keene, carrying on business under the style of N. & D. Keene, at 78, Llewellyn Street, Pontgwaith, Glam, as a radio, television and electrical contractor.—Public examination 3rd October, at the Court House, Courthouse Street, Pontypridd, Glam.

D. L. Stoneham, 3, Crombey Street, Swindon, Wilts, electrical contractor, lately carrying on business at that address.—First and final dividend of 1s 1¾d in the £, payable at the Official Receiver's office, 26, Baldwin Street, Bristol, 1.

Charges for H.V. Supplies

LAST week the House of Lords, in a reserved judgment, dismissed an appeal by the South of Scotland Electricity Board and the Central Electricity Authority from a decision of the Second Division of the Court of Session on 10th June, 1955, in an action by the British Oxygen Co., Ltd., Hillington, Glasgow, allowing the parties a proof before answer. The Lord Ordinary (Lord Hill Watson) had dismissed the company's action, holding their averments irrelevant and lacking in specification.

Lord Normand said the company alleged undue discrimination against industrial users of high voltage electricity. They claimed that three tariffs on which they were to be charged were invalid and contrary to the Electricity Act, 1947, which stated that the Board should not show "undue preference" or exercise "undue discrimination" as between one class of user and another. The undue discrimination complained of lay in the narrowing of the gap between the unit prices charged for high voltage and low voltage supplies respectively.

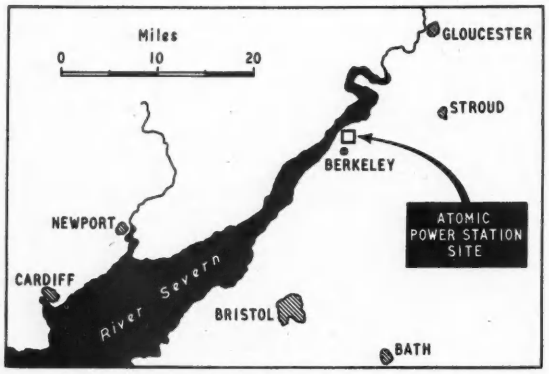
After saying that on the arguments adduced before the lower Courts he agreed with the view taken by the Inner House, Lord Normand referred to new arguments introduced when the appeal was heard by the House of Lords. The Electricity Board claimed that the test of whether a preference had been shown was simply a matter of price. This new submission was crucial to the decision of the action and was of the greatest importance to all users of electricity and also of gas. It was in substance a new case that the House was asked to consider without the aid of the judgment of the Court of Session. He would dismiss the appeal, with costs.

Viscount Simonds, Lord Tucker, Lord Cohen and Lord Keith of Avonholm agreed.

Berkeley Nuclear Station

Second C.E.A. Project Approved

THE Minister of Fuel and Power has notified the Central Electricity Authority of his consent to the establishment of the proposed nuclear power station at Berkeley on the Severn Estuary in Gloucestershire. This follows the Minister's consent to the building of the nuclear power station at Bradwell, in Essex, as reported in last week's issue of the *Electrical Review* (page 122). As in the case of Bradwell, approval is given to the erection of a station at Berkeley containing turbo-generator sets having an aggregate electrical output of about 200,000 kW, and two carbon-dioxide gas cooled, graphite moderated reactors.



Map showing the site of the nuclear power station to be built by the Central Electricity Authority on the Severn Estuary

Berkeley and Bradwell will be the first two of the twelve stations envisaged in the Government's nuclear power programme as outlined in the White Paper of February, 1955.

Proposals of four industrial groups of manufacturers for the design and construction of the two stations are due in October. The necessary preliminary works at both Berkeley and Bradwell are being put in hand so that there will be no delays and actual construction work at the sites is expected to start in the New Year.

Larger Generating Sets

More 120 MW Reheat Units

THE Central Electricity Authority has received the approval of the Minister of Fuel and Power to install in the new power station to be built on the Trent at Rugeley, near Stafford, two 120,000 kW turbo-generator sets, instead of four 60,000 kW sets authorised in the Minister's consent to the establishment of this station, which was received by the Authority in July of last year.

This change is the result of a review of the generating plant programme which has been undertaken by the Authority and represents a development which will affect the proposed plant installations in five new power stations. Subject in certain cases to the Minister's consent, 26 units of 60,000 kW each which were planned for installation in these stations are to be replaced by 13 units of 120,000 kW each. The stations, in addition to Rugeley, in which it is proposed to substitute these larger sets are Staythorpe "B," for which the plant has already been ordered, Skelton Grange "B," Uskmouth "B" and Belvedere.

Some delays will occur in the planned commissioning dates for the plant in these stations and arrangements are being made to make up the resultant loss of capacity by accelerating the installation and advancing the commissioning of 60,000 kW units in other stations in the programmes.

The development of the design of the 120,000 kW reheat unit in conjunction with the evolution of improved operating techniques to the stage where it is considered that these units can be used for two-shift loading at a relatively early stage of operation, has made possible this change in the plant programme.

Costs Reduced

It is estimated that substantial economies in capital costs will be effected by the substitution of the 120,000 kW units, not only in the plant itself, but also in the cost of the main buildings and civil engineering works, including the circulating water system. Moreover, the larger units will be considerably more efficient in thermal performance than the 60,000 kW units and will yield a substantial saving in the amount of fuel required, an advantage that is accentuated by the recent increases in the price of coal.

The trend towards the adoption of larger generating sets in the new power stations under construction and planned is reflected in the orders which have already been placed for plant of 100,000, 120,000 and 200,000 kW capacity. Few further 60,000 kW sets will be installed by the Authority, except where circumstances preclude the installation of the larger sizes.

Level Tendering

Questions on Lord Citrine's Speech

LAST Monday Mr. Holt asked the Minister of Fuel and Power whether "in view of Lord Citrine's support in his official capacity for certain restrictive trade practices, and his inability thereby to safeguard the interests of the Central Electricity Authority and the users of electricity" he would terminate his appointment as chairman of the C.E.A.

Mr. Aubrey Jones said he assumed that this referred to the speech which Lord Citrine made recently at a study conference, all the speakers at which spoke as private individuals rather than in their official capacity and were enjoined by the chair to be provocative, and even heretical. He was satisfied that Lord Citrine's response to this injunction would in no way bear the interpretation that he was unfitted to safeguard the interests of the C.E.A.

Mr. Holt asked if the Minister had inquired whether the views that Lord Citrine expressed were in fact the official views and policy of the Authority of which he was chairman. If that was so, did the Minister not feel any alarm that a nationalised industry spending huge sums of money should not be at all concerned about level tendering?

Mr. Jones gave quotations from Lord Citrine's address and said that these words did not indicate any disregard or indifference to the interests of the Authority. In reply to Mr. Nabarro he said the declared policy of the Government with regard to price rings was enshrined in the Restrictive Trade Practices Bill. The words which he had quoted from Lord Citrine's speech were entirely consistent with the Bill. In other words, level tendering or collusion might be justifiable in certain circumstances, and the criteria were set down in Clause 16 of the Bill.

In answer to another question by Mr. Holt, he said that in so far as the nationalised industries entered into restrictive agreements they would be subject, like other industries, to the provisions of the Restrictive Trade Practices Bill, except of course in the case of agreements expressly authorised by statute.

Replying further to Mr. Nabarro, the Minister said it was a fact that the trend of capital costs in the electricity supply industry was lower than the trend of costs in general.

Industrial Power Factor Correction

Review of Rotary and Static Methods

By W. A. BRECKNELL, A.M.I.E.E.*

THE widespread introduction in this country of industrial tariffs incorporating power factor penalties has made power factor correction a matter of paramount importance to most industrial consumers. Because of these penalties, considerable financial savings may be obtained by installing p.f. correction equipment. In addition, factory electrical systems may benefit from reduced copper losses,[1] improved voltage regulation and increased plant capacity. High system p.f. is also of particular value to concerns which generate their own electricity, and in certain cases valuable increases in kW capacity may be achieved without installing new generating plant.

In this article it is assumed that p.f. correction has been proved to be an economical proposition[2] and so it is more a review of current practice, comparing rotary and static methods, rather than an economic treatise.

For many years before the industry was nationalised certain supply authorities had instituted industrial tariffs which incorporated a power factor penalty or bonus, or both. These tariffs and clauses were many and varied, but shortly after nationalisation there was a trend towards standardisation. At present, while a national industrial tariff is not yet in being, standardisation within Area Board boundaries has, for the most part, been achieved. Out of a total of fourteen Area Boards (including the North of Scotland Hydro-Electric Board) twelve have instituted a standard industrial tariff with a p.f. clause. In this article it is not intended to discuss tariff structures in detail, but interesting facts on the evolution of standard industrial tariffs have been ably presented by Johnson and Marsh, in a recent I.E.E. paper.[3] There is little doubt that soon nearly every industrial consumer in this country will be penalised for low p.f.

Although the most publicised disadvantage of low p.f. is an increase in charges, there are other disadvantages, almost as important from the viewpoint of system efficiency, and these fall broadly into three categories. First, the uneconomical use of copper, which is made abundantly clear when it is realised that to transmit 200 kW at 0·6 p.f. on a 400 V, three-phase supply requires double the amount of copper that would be necessary for the same load at 0.9 p.f. This assumes a cable run of 150 yd, which is common in industrial distribution systems.

Secondly, limitation of system kW capacity, which applies particularly to concerns generating their own electricity, or to mains-fed consumers taking an e.h.v. supply from an Area Board. When the kVA capacity of the plant has been reached before the kW requirements have been met the result is overloaded plant, with the attendant evils of increased maintenance and possible stoppage of production. Finally, low p.f. is responsible to a large extent for bad voltage regulation.

Table I shows the increase in kW transmitting capacity effected by improving the p.f. of a load transmitted by an 11kV overhead line, 12 miles long, the initial load being 720kVA at 0.6 p.f. lagging, the permissible regulation being 5 per cent. It will be noted that by raising the p.f. of the transmitted load from 0.8 to unity, it is possible to almost double the kW capacity of the line.

* British Insulated Callender's Cables, Ltd.

The effect of load p.f. and transformer reactance upon transformer voltage regulation is shown by the approximate values plotted in Fig. 1. This is for a 1,000 kVA transformer having the typical values of 5 per cent reactance drop and 1 per cent resistive drop.

There is a wide variation in inherent p.f. values for various types of industry, and Table II indicates typical values encountered in practice. These are general figures only and there will be various individual cases where the load p.f. differs considerably from the quoted figures.

Instances of loads having high inherent power factors, of the order of 0.8 and above, may be due to most of the motors working at a high load factor, or to the type of load which permits of high duty starting requirements being overcome by mechanical means. The converse is, of course, true for loads having a low inherent p.f.

The growth of individual drives in certain industries constitutes a disadvantage from the viewpoint of p.f. At

TABLE I

P.f.	Amps.	kVA	kW	Percentage increase in kW load
0.6	37.7	720	432	—
0.7	38	725	507	17.35
0.8	39	745	597	38.2
0.9	41.8	800	720	66.7
0.95	45	860	817	89
1.0	60.7	1160	1160	168.5

LINE CONSTANTS AND DATA

Sending end voltage 11 kV. System three-phase. Conductors 7/.136 h.d. copper. Spacing 48 in. Resistance 0.4350 Ω/mile. Reactance 0.5841 Ω/mile. Regulation 5 per cent. Initial load 720 kVA at 0.6 p.f.

Based on the well-known formula

$$e = \sqrt{3}\, I\, (R \cos \phi + X \sin \phi)$$

where e = volts drop, I = line current and ϕ = angle of lag

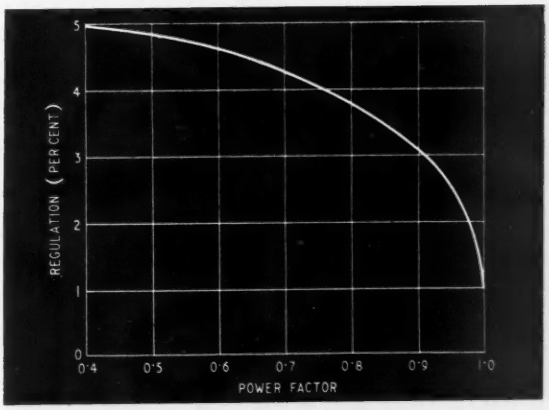


Fig. 1.—Variation of transformer regulation with p.f. based on a load of 1,000 kVA. Resistive drop 1 per cent. Reactive drop 5 per cent

TABLE II

Industry	P.f.
Textile	
Weaving (individual drives)	0.55/.65
Mule spinning	0.7
Worsted cap or fly spinning	0.78/.85
Rag grinding	0.7/.75
Chemical Industry	0.75/.85
Engineering	
Machine shops	0.4/.65
Boiler shops	0.4/.5
Arc welding	0.35/.4
Resistance welding	0.6
Arc furnaces	.75/.9
Induction furnaces (mains frequency)	0.7/.75
Cement Works	0.78/.8
Clothing Factories	0.35/.6
Breweries	0.75/.8
Steelworks	0.7/.85
Collieries	0.65/.8

any instant in a machine shop 40/50 per cent of the motors may virtually be running idle, with obvious results.

The induction motor is the most widespread contributor to the reactive load in a system. Its p.f. tends to increase with increase in h.p. rating for a given speed. Similarly, for a given h.p. rating, the p.f. decreases with decreasing speeds. Thirdly, the p.f. decreases with reduced load conditions. These facts are illustrated by Figs. 2, 3 and 4 on the facing page.

It may be possible by rearrangement of existing motors, to obtain a better overall load factor, and hence a better system p.f. Where new plant extensions are envisaged, attention should be paid to the selection of motor h.p.'s in relation to the duty involved, and to the speed of the drive. It might also be possible to group some machines together and use a larger motor to drive several machines. Obviously, it is not possible to benefit from close rating of motors in many cases owing to the varying load duties required from the machines.

The essence of p.f. correction is the neutralisation of lagging kVAr by introducing leading kVAr in the system. The generation of leading kVAr may be effected at various points in the system by synchronous condensers, synchronous motors or power capacitors. In this country, generation of reactive power, with few exceptions, is carried out locally by the consumer, usually as a result of tariff incentives. Whether the Central Electricity Authority or Area Boards will extend the practice of generating reactive power on their own systems, to meet supplementary requirements, remains to be seen.

The amount of leading kVAr necessary to effect a given degree of p.f. correction may be calculated from the following formula:—

$$\text{CkVAr} = \text{kW}\,(\tan\phi_1 - \tan\phi_2)$$

Where ϕ_1 = initial angle of lag.

ϕ_2 = required corrected angle of lag.

kW = 3 phase kW load.

It is evident that the first step in designing a p.f. correction scheme is to obtain an accurate assessment of the load and p.f. and this may be done in one of the following ways:—(a) Measurement of voltage, current and kW. (b) Measurement of kW and kVAr, and obtain p.f. indirectly. (c) Use of the two wattmeter method of registering total three-phase power. (d) Measurement of kVA and kVAr and obtain p.f. indirectly. (e) Use of p.f. indicator, ammeter and voltmeter.

Using any of the above methods "spot" tests may be taken, if the load is fairly steady; alternatively, using integrating metering, tests may be taken over a definite time period. The most suitable method of testing may be dictated by the type of tariff in operation.

Various formulae have been evolved to determine the most economical p.f. level. According to Cundall[1] the figure is generally higher for tariffs embodying a kVA demand charge than for tariffs offering a kW demand charge with p.f. clause and for the former type of tariff, correction to 0.98 p.f. is justified economically.

If consumers will accept a return of capital outlay in two or three years, then it is usually the type of tariff which fixes the corrected p.f. level. In areas where there is no incentive for correction above 0.9 p.f., there is no object in correcting to a higher figure. In areas offering a kVA demand charge, there is no reason why correction to 0.97 p.f. should not be justified.

For concerns generating their own power, where p.f. correction may be required to release electrical system capacity, a p.f. of 0.85 to 0.9 is usually adequate. If it is desired to run industrial alternators at lagging power factors in excess of the rated p.f. characteristic, it is usual to consult the machine manufacturers before doing so.

Rotary Methods

Books often give the impression that the two broad methods of p.f. correction, by rotary or static means, are equally applicable to every case. In practice, this is far from true. There are many instances where synchronous machinery is the obvious method, just as there are many instances where the power capacitor is unchallenged. It is impossible to evolve a direct basis of comparison to meet all cases, and each scheme should be considered individually.

There are three main groups of rotating machinery; synchronous condensers, synchronous motors, and synchronous induction motors. Synchronous condensers are rarely used in industrial applications, because they cannot be justified economically in the sizes which could be universally applied to industrial loads. Machines of about 5,000 kVA may be an economical proposition but their application is restricted mainly to the very large loads associated with steel works, etc.

Synchronous condensers are virtually synchronous motors with a specially designed excitation system which enables them to provide lagging or leading kVAr. Their main application is for stabilising voltage regulation on long transmission lines, particularly on hydro-electric systems, and thus helping general system stability. For such duties, units rated at 20/30 MVA, are common, and although many are made in this country none are used on the Central Electricity Authority system.

As the "over-excited" synchronous motor runs at a leading p.f. it can be used for p.f. correction. It should be stressed that the term "over-excited" is misleading. A machine is designed to operate at a given load and p.f., which implies the full load condition for stator and excitation circuits. Attempts to "over-excite" will result in undesirable current overloading.

The normal synchronous motor may be of the salient pole or smooth rotor type. The former has a slightly greater overload capacity and slightly higher efficiency, and may be applied with advantage to low speed drives. The synchronous motor is rendered self-starting by incorporating a cage winding in the rotor, making the machine behave, during starting, like a squirrel cage induction motor. When the speed approaches synchronous the machine pulls into step and runs at synchronous speed.

The complication which might arise through having d.c. imposed on the a.c. in the rotor during starting is overcome in the design of the exciter system. Not until the speed approaches synchronous does the exciter commence to

build up. To limit the starting current with this arrangement it is necessary to employ auto-transformer starting.

Synchronous motors may be designed to run at any desired leading p.f. and load, although the first cost and efficiency will be at a minimum and maximum respectively for unity p.f. conditions. If the motor is to be connected to a factory system where the p.f. is already at a high value, then a full load operating p.f. of unity should suffice. If, however, it is desired to use the motor to boost the p.f. of the existing load, then it will require to run at a leading p.f. and the exciter capacity and frame size may need to be increased accordingly.

When running at mechanical loads below that for which it was designed, the synchronous motor is stable at any p.f. within its kVA rating. The disadvantage of the ordinary synchronous motor is that it will only start against a light load torque, if excessive starting currents are to be avoided. For this reason, it is best used where the starting conditions are light as for example on large ventilating fans for collieries, motor-generator sets, or centrifugal pumps. In general the efficiency of the synchronous motor at unity p.f. is slightly superior to that of the induction motor.

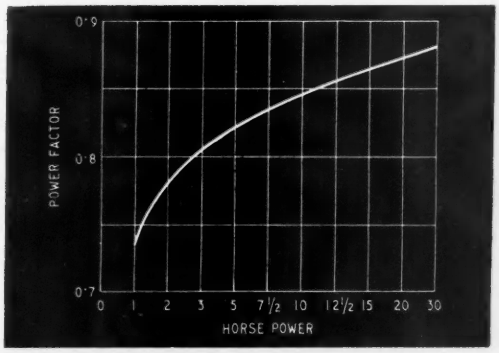


Fig. 2.—Typical full load p.f. values for 1,000 r.p.m. s.c. induction motors of various h.p. ratings

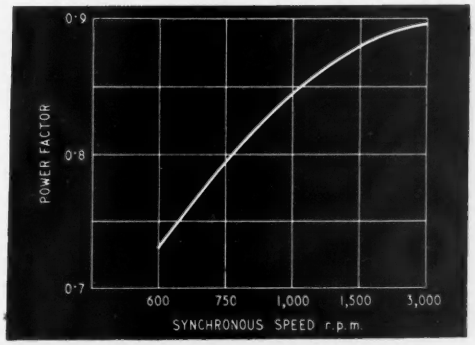


Fig. 3.—Typical full load p.f. values for 10 h.p. s.c. induction motor at various speeds

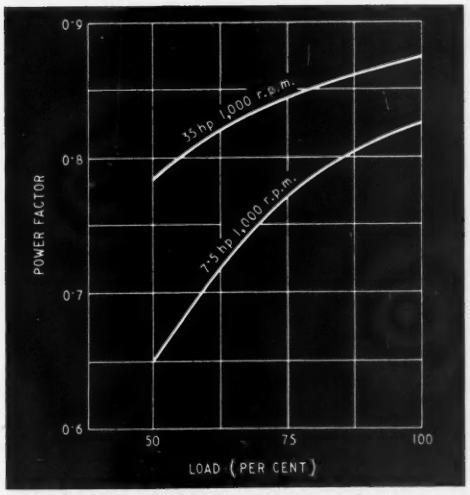


Fig. 4.—Variation of p.f. with load on s.c. induction motors

The synchronous induction motor[5] is more than equal to the ordinary synchronous motor for p.f. correction purposes, and can be designed to operate at any required load and leading p.f., but minimum first cost and maximum efficiency will be achieved only when the machine is designed to operate at unity p.f. The s.i.m. is similar to the slip-ring induction motor in that it has a wound rotor and is started in the same fashion. It incorporates a d.c. exciter, and has a lower slip than an induction motor to facilitate synchronising, but has the longer air gap associated with the synchronous motor proper.

During starting, when the speed is approaching synchronous the d.c. excitation is switched on, or built up according to the design, and the motor pulls into step and behaves thereafter largely as a synchronous motor. Like the synchronous motor, it will remain stable at any p.f. within its kVA rating, but it should be stressed that, from the point of view of p.f. correction, the best results will be obtained when the driven load is constant and continuous.

The extra advantage of the s.i.m. over the ordinary synchronous motor is that it can start against full load torque without drawing an excessive kVA starting load. A normally rated unity p.f. machine may only take about $1\frac{1}{2}$ times full load kVA for a start against full load torque, and a machine designed for 0.8 p.f. lead takes less than this, in fact about $1\frac{1}{4}$ times full load torque.

If the s.i.m. is driving plant with a fluctuating load it may be desirable to vary the excitation at light load periods as the leading p.f. resulting from constant excitation with reduced load may prove an embarrassment rather than an advantage. Excitation control would apply particularly to factories generating their own power where the alternators may become unstable with light load and leading p.f. conditions. In such cases, it is possible to arrange for a system of automatically variable excitation.

The ability to start against full load torque makes the s.i.m. applicable to a far wider range of drives than the normal synchronous motor and hence increases its value as a medium for p.f. correction. Some typical applications for the s.i.m. are:—Compressors, ventilating fans, pumps, blowers, ore crushers, grinding mills in cement works, flour mill main drives, rubber mixing plants, and paper mills.

The phase advancer method of p.f. correction is not in general use nowadays[2] although about twenty years ago it was thought to have a bright future. Phase advancers may be fitted to existing slip-ring motors or may be designed for and installed with a specific motor. In the first case, the overall efficiency may be reduced by as much as 2 per cent, but in the second case, the efficiency may be improved when compared with an ordinary slip-ring motor.

In effect, phase advancers supply current to the rotor of the induction motor, and hence alter the phase relationship of the stator current to the voltage, thus improving the p.f. To ensure maximum efficiency, and to avoid commutation troubles, a high rate of maintenance is required which may account for the restricted use. The phase advancer is usually applicable down to motors of 50 h.p. of the slip-ring pattern.

A development of the phase advancer is, in some respects, seen in various forms of commutator motor. In addition to the normal rotor and slip rings, a secondary winding is mounted on the shaft, complete with commutator and brushgear. The machine is started as a slip-ring induction motor and the brushes are pre-set to give a p.f. of about 0.95/unity. High speed machines of this type may have a lower first cost than an induction motor/capacitor combination at ratings above 100 h.p. This level may be raised for slower speed machines where additional poles and brushgear are required.

Use of Power Capacitors

The evolution of the power capacitor over 40/50 years has produced equipment of great reliability. The advantages of capacitors for p.f. correction are flexibility of application, high efficiency (99.85 per cent) and negligible running costs, minimum maintenance, reliability and the fact that they require no special foundations.

For small and medium sized loads, the superiority of capacitors is unchallenged. They can also be applied to very large loads, and very often high p.f. in large plants is achieved by a combination of static and rotary correction.

If the flexibility of the capacitor is to give optimum results detailed attention must be given to the siting, application and control of the equipment. Table III shows how capacitor application schemes may be broadly classified.

TABLE III

Application	Location	Control
Centralised correction	Main busbars or substation	Manual or automatic
Group correction	Main distribution points in factory	Manual or automatic
Individual motor correction	Directly across motor	Switched with motor

These divisions are by no means fixed and schemes may consist of a compromise between two or even all the methods listed. Capacitors are best connected on the l.v. side of the system except where parts of the load are fed direct from the e.h.v. system.

Manually controlled capacitors are usually employed on centralised correction schemes for factory loads, which are too small to warrant splitting up the capacitance required and where the high diversity of the motor load precludes individual motor correction. Capacitors up to about 40 kVAr may be controlled by air-break switch fuses of the h.r.c. pattern, but it is advisable to allow liberal fuse ratings as the switch and fuses have to carry continuously the full rated current. To allow for voltage variation and harmonics it is advisable to select an h.r.c. link having a rating at least 50 per cent above the nominal capacitor current.

For the manual control of capacitors above 40 kVAr, it is usual to employ an oil circuit-breaker or air-break contactor, derated to 80 per cent of its nominal rating. The only situations where large banks of manually controlled capacitors may be justified are industrial plants engaged on continuous process work, where the minimum of capacitor switching occurs. In such cases, the largest sizes of capacitors may be used with advantage.

Automatically controlled capacitor banks are most suitable for loads comprising a large number of motors operating with high diversity, machine shop loads being a typical example. Relays operated by voltage variation,[6] current or kVAr[7] may be employed for automatic control. Voltage control appears to be restricted to the United States and current control has only been used to a limited extent in this country, the main disadvantage being that this method does not necessarily give a close p.f. control.

The third method is perhaps the most logical as the capacitors are switched according to the variations in kVAr load. It has been well tried in practice, and there are several reliable makes of reactive relay available which will give single-stage or multi-stage control. Reactive relays consist of a movement of the watt-hour meter type, with the current and potential coils connected so as to obtain 90 deg phase displacement at unity p.f.

Single stage control may be applied to single capacitors correcting relatively small loads or to single capacitors connected at the ends of main factory distributor cables, forming part of an overall correction scheme. The latter method may be used advantageously when capacitors are at the ends of very long factory distributors, thus cutting out long runs of control wiring. To obtain maximum operating efficiency, however, it is necessary to have an accurate assessment of the load on each individual distributor. Ingeneral, the automatic switching of more than one capacitor is best achieved by the use of multi-stage relays which give a more accurate control of overall p.f. Capacitors for use with relay control usually embody a contactor mounted on the tank.

The practice of connecting a capacitor across the stator of an induction motor and switching the motor and capacitor as one unit is well-established. Owing to the comparatively small variation in motor kVAr from zero to full load (25/30 per cent) compared with kW, the effectiveness of individual motor correction is not impaired by variations in motor load, and one size of capacitor will give a substantially constant value of p.f. over the normal working load range. For motors up to about 100 h.p., the combination of motor and capacitor may be cheaper in first cost than a s.i.m. or other self compensating motor. Combination switching eleminates the necessity for separate control gear for the capacitor and also ensures automatic control and flexibility, with minimum variation in p.f.

Further advantages are that the benefits of p.f. correction are distributed over the entire factory electrical system,[1] and that motor starting conditions are improved. This improvement is effected, not because the capacitor of itself improves the motor starting torque, but because the phase displacement of the line current at starting is changed. This reduces voltage drop, so increasing the available starting voltage at the motor terminals.

The ideal case for individual motor correction is where large induction motors are employed for group drives, or for specific items of plant, and where the diversity is low. In such cases individual correction will provide a near perfect p.f. improvement scheme, giving absolute flexibility, accurate p.f. control, and the minimum of capital outlay. Motors selected for individual correction should be those which form the base load or which are certain to be running at periods of maximum demand. Where diversity exists, individual correction of all motors may not be economical if first cost is the deciding factor. In such cases, the balance of the capacitor equipment to correct to a desired p.f. which cannot be connected directly across motors, may be connected to the main busbars, or to other suitable points on the factory distribution system, and controlled automatically.

The practice of over-correcting large induction motors[8, 9, 10] to compensate for a number of smaller machines on the same system is not permissible on technical grounds. Although a capacitor and motor combination may run together at a leading p.f., serious disturbances

TABLE IV

H.p.	R.p.m. (Sync. speed)	Size of capacitor in kVAr	
		Squirrel cage	Slip-ring
5	1,500	1.75	2.25
	1,000	2.0	2.75
	750	3.0	3.5
7.5	1,500	2.75	3.25
	1,000	3.25	4.0
	750	4.0	4.5
10	1,500	3.25	4.25
	1,000	3.75	4.75
	750	5.0	5.5
15	1,500	4.25	5.5
	1,000	5.25	6.0
	750	6.5	7.5
	600	8.0	8.5
20	1,500	5.5	6.0
	1,000	6.5	7.5
	750	7.5	9.0
	600	10	11.0
30	1,500	7.0	8.5
	1,000	9.0	10.5
	750	11.0	12
	600	14.0	15

may occur when switching, because over-corrected motors can become self excited when disconnected from the supply, and dangerous over-voltages may result, causing damage to both motor and capacitor. The condition is aggravated when the method of starting involves temporary disconnection from the supply, as in auto-transformer and star-delta starting, particularly when the driven load possesses high inertia.[11] In such cases transient torques up to about 25 times full load torque may result with consequent damage to shafts and bearings.

The correct size of capacitor for individual motor correction should have a kVAr rating not exceeding the no-load magnetising kVAr of the motor. Where star-delta starting is employed, it is preferable that the capacitor should be fitted with six terminals.[11] It is also preferable that induction motorshaving intermittent or short time h.p. ratings should not be corrected individually by means of capacitors. Similarly, individual application of capacitors should usually be avoided in cases where motors are driving lifts, cranes, colliery winders and the like, and in cases where direct reversal or " plugging " is employed. Table IV gives a guide to the maximum sizes of capacitors suitable for connection across three-phase 50 c/s motors.

The methods of p.f. correction in everyday use have been analysed briefly and are clearly divided into the static and rotary classes. The comparison between the two broad methods of correction is by no means so clear cut. It is not a question of using rotary or static correction, but rather deciding the circumstances which justify the economical use of one method or the other, and the problem is usually reduced to consideration of each case individually.

For existing loads, where the motive power is provided by induction motors and whether the load is large, medium or small, power capacitors provide the best method of p.f. correction. For projected layouts, if the question of p.f. correction was considered at the drawing-board stage, then a wider use of synchronous machinery might be envisaged. For new projects where production requirements dictate the use of individual drives, then capacitors will probably provide the answer. Where, however, there is a demand for extra and mainly continuous motive power which can be conveniently group driven, or which is in the form of one machine, then a synchronous motor drive may well prove to be the most economical method of p.f. correction.

Although the first cost of capacitor/induction motor combinations or synchronous motors may not be the only criterion, it is one of the most important factors in selection. In general the capacitor/induction motor combination costs less than the synchronous motor in the lower h.p. range, while the synchronous motor or s.i.m. has the advantage in the higher h.p. range. But there is a variation in the ranges depending upon the amount of kVAr to be supplied. Furthermore, the comparison must be made between motors using similar control gear for starting i.e. between the slip ring induction motor and s.i.m., or between the s.c. induction motor and the synchronous motor proper.

In the case of the s.r. induction motor and capacitor versus the s.i.m., the advantage lies with the s.i.m. at *about* 250 h.p. and upwards. In the case of the s.c. induction motor/capacitor group, and the salient pole synchronous motor, the advantage lies with the synchronous machine in sizes above 500/750 h.p. This assumes that the machines are operating at medium voltage and at a p.f. between 0.95 lag and unity.

When the synchronous machine is required to operate at a p.f. of say 0.8 lead, then the h.p. range where the synchronous motor has the advantage is only about 50 per cent of the above figures. This is because it is not permissible to over-correct a single induction motor to compensate for the rest of the load, and while a s.i.m. or synchronous motor designed to operate at a leading p.f. will cost more than a machine of equal h.p. operating at unity p.f., the leading kVAr produced by the rotary method of correction will cost less than a capacitor bank with automatic control.

Initial cost may not be the only criterion. For instance, the synchronous motor or s.i.m. is run to produce kVAr, and hence, it should only be selected for continuously running drives. Smooth kVAr control is obtainable from the synchronous motor by variation of excitation. This can be done automatically, but adds to the first cost. The constant speed of the synchronous machine may dictate its selection (e.g. frequency change sets), but it may equally preclude its use for drives such as Ilgner - Ward Leonard sets. Owing to large air gap, the synchronous motor lends itself to being made as a single bearing machine for certain drives, thereby economising in length of bedplate etc., and capital cost. Generally speaking the synchronous motor family are apt to require more maintenance than a capacitor/induction motor group.

The author wishes to thank Mr. P. Huggins of Lancashire Dynamo & Crypto, Ltd., and also his colleagues on the staff of British Insulated Callender's Cables, Ltd., whose advice has been of invaluable assistance in the preparation of this article.

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10451. Badische Anilin- & Soda-Fabrik Akt.-Ges.—Production of the supports or carriers for the active material of electric accumulators. 9th April, 1954. (753755.)

10829. Western Electric Co., Inc.—Electric circuits employing transistors for the generation of frequency modulated oscillations. 13th April, 1954. (754156.)

11708. Landis & Gyr Akt.-Ges.—Electromagnetically operated counting devices. 22nd April, 1954. (753759.)

13293. Electric Storage Battery Co.—Electric storage battery plates. 6th May, 1954. (753768.)

13372. Standard Telephones & Cables, Ltd.—Electrical multiplication circuit. 7th May, 1954. (753918.)

15159. Masson, E. P.—Electric thermostat for refrigerator cabinet. 24th May, 1954. (753775.)

16094. British Thomson-Houston Co., Ltd.—Apparatus for mounting filaments for incandescent electric lamps. 31st May, 1954. (754032.)

16849. Kaiser Aluminum & Chemical Corporation.—Aluminium sheathed cable and method for making same. 8th June, 1954. (753935.)

17550. Raibourn, P.—Colour television system. 15th June, 1954. (754037.)

17724. Radio Corporation of America.—Cathode-ray tube circuit arrangement. 16th June, 1954. (754169.)

19175. Philips Electrical Industries, Ltd. —Devices for registering coded information. 30th June, 1954. (753944.)

19468. Compagnie Générale de Télégraphie sans Fil.—Frequency modulated distance measuring radio equipment. 2nd July, 1954. (753785.)

20114. Roanoid Plastics, Ltd., and Richardson, T. A.—Insulator for electrified fencing. 7th July, 1955. (754049.)

20143. Bolton & Sons, Inc., J. W.—Magnetic separator. 9th July, 1954. (753790.)

20983. Philips Electrical Industries, Ltd. —Miniature electrolytic capacitors. 19th July, 1954. (753949.)

21139. General Electric Co.—Dynamo-electric machines. 20th July, 1954. (754175.)

21151. Ramsey, A. R. J. (McGrew Electric Co.).—Three-phase transformers. 20th July, 1954. (753795.)

21234. Prince, D. C.—Manufacture of insulated electric cables. 21st July, 1954. (753950.)

22060. Philips Electrical Industries, Ltd. —Stabilised transistor oscillators. 28th July, 1954. (753953.)

26407. Allmanna Svenska Electriska Aktiebolaget.—Nuclear chain reactors. 13th September, 1954. (754183.)

26489. Hoover, Ltd.—Suction cleaners. 13th September, 1954. (753968.)

26685. Licencia Talalmanyokat Ertekesito Vallalat.—Automatic load dependent Y-delta change-over system for electric induction motors. 14th September, 1954. (754066.)

28003. Boeing Airplane Co.—Anti-hunt means for electric motor positioning system. 28th September, 1954. (753816.)

28661. Armstrong, E. M.—Multiplex frequency modulation transmitter. 5th October, 1954. (754185.)

28923. Philips Electrical Industries, Ltd. —Transistor pulse oscillators. 7th October, 1954. (754187.)

29298. Philips Electrical Industries, Ltd. —Screened spaces for high-frequency dielectric heating of workpieces. 11th October, 1954. (754073.)

30238. Compagnie pour la Fabrication des Compteurs et Matériel d'Usines à Gaz.—Arrangements for the regulation of the frequency of a rotary convertor. 20th October, 1954. (754077.)

31917. Pirelli Soc. Per Azioni.—Electric cables. 4th November, 1954. (754079.)

31956. General Electric Co.—Surface finishing of zirconium and alloys thereof. 4th November, 1954. (754188.) 31957. Surface finishing of titanium and alloys thereof. 4th November, 1954. (754190.)

32402. Philips Electrical Industries, Ltd. —Devices comprising an X-ray apparatus and an electronic image convertor. 9th November, 1954. (754080.)

33089. Union Carbide & Carbon Corporation.—Anodes for primary galvanic cells. 16th November, 1954. (754194.) 33090. Duplex electrodes for primary electric batteries. 16th November, 1954. (754195.)

33785. Skillman & Co., Pty., Ltd., T. S.—Receiver for carrier telephone systems. 22nd November, 1954. (754083.)

34192. Stahl, A., Stahl, O., Stahl, O., and Stahl, B.—Suspension controllers for electric drives. 25th November, 1954. (754197.)

34222. General Electric Co.—Electrical vapour detectors. 25th November, 1954. (754087.)

34263. Telefonaktiebolaget L. M. Ericsson.—Devices which include secondary emission electronic tubes for independently establishing and maintaining one (or more) electronic signal transmission path(s). 25th November, 1954. (754088.)

34330. Standard Telephones & Cables, Ltd.—Electric transformer circuits. 26th November, 1954. (754089.)

35976. Compagnie Générale d'Eléctricité. —Devices for detecting faults in long distance electric cables. 13th December, 1954. (754200.)

36226. Sangamo Weston, Ltd.—Sealed adjusting devices for instrument cases. 14th December, 1954. (753837.)

36755. Philips Electrical Industries, Ltd. —Methods of manufacturing laminated ferromagnetic cores. 20th December, 1954. (754097.)

37070. Akt.-Ges. für Technische Studien. —Tubular heaters. 22nd December, 1954 (754098.)

37084. Telefunken Ges.—Cooling arrangements for electric discharge devices. 22nd December, 1954. (754201.)

1955

30042. Higonnet, R. A. E., and Moyroud, L. M.—Digital multipliers. 26th September, 1952. (754208.)

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses.

Aberdeen.—11th August. Harbour Commissioners. Electrical fittings for one year from 1st October. Harbour engineer, 15, Regent Quay.

Australia.—8th August. Victorian Railways, Melbourne. 22 "Alliance" automatic couplers. (E.S.B. 17736/56. Ten/20264.)* 15th August. 1,000 disc type transmission insulators. (E.S.B. 18442/56. Ten/20371.)*

6th September. Sydney County Council. Fuse and switch units. (E.S.B. 17782/56. Ten/20276.)*

6th September. Commonwealth of Australia. Transmitters and parts. (E.S.B. 17876/56. Ten/20316.)* 11th September. 114 electron tubes. (E.S.B. 17875/56. Ten/20291.)*

Camborne-Redruth. — 10th September. U.D.C. Electrical equipment for street lighting. Engineer and surveyor, Council Offices, Camborne, Cornwall.

Edinburgh.—North of Scotland Hydro-Electric Board. 33 and 132 kV switchgear for Port Ann substation, Lochgilphead. (See this issue.)

India.—1st August. Government of Mysore, Stores Purchase Committee. Transmission line materials for the Shimoga-Bhadra 66 kV transmission line. (E.S.B. 17576/56. Ten/20270.)*

1st August. Director General of Supplies and Disposals. 315 ground electric starter trolleys. (E.S.B. 17723/56. Ten/20278.)* 24th August. Insulated cables. (E.S.B. 17888/56. Ten/20277.)*

New **Zealand.**—23rd August. General Post Office. 49 miles of jumper wire. (E.S.B. 17990/56. Ten/20274.)*

Pakistan.—1st August. Department of Supply and Development, Karachi. Electrical apparatus including sockets, switches, fuses, meters, panels, and wire. (E.S.B. 18443/56. I.C.A. Ten/20367.)* Measuring and testing instruments. (E.S.B. 17643/56. Ten/20253.)*

10th August. Posts and Telegraphs Department. Eight 20-line private manual branch exchanges. (E.S.B. 17647/56. Ten/20251.)* 25th August. Underground cables. (E.S.B. 18113/56. Ten/20311.)* 16th August. Three-channel v.h.f. link connecting Karachi, Sonmiani, Ormara, Pasni and Jiwani. (E.S.B. 18049/56. Ten/20347.)* 3rd September. Carrier cable system to operate between Karachi and Hyderabad Sind. (E.S.B. 18048/56. Ten/20340.)*

Peterhead.—18th August. Burgh Council. Street lighting equipment. (See this issue.)

South Africa.—3rd August. Telephone Department, Durban City Corporation. 83 telephone switchboards. (E.S.B. 17962/56. Ten/20294.)*

6th August. Stores and Buying Branch, City of Johannesburg. 600 electricity meters and 450 test blocks. (E.S.B. 18119/56. Ten/20292.)*

7th August. Stores Department, Cape Provincial Administration. Thirteen 220 V a.c. floor polishers. (E.S.B. 18098/56. Ten/20343.)*

10th August. Stores Department, South African Railways. Telegraph line material. (E.S.B. 17738/56. Ten/20314.)*

Turkey.—15th August. Ankara Electric, Gasworks and Motorbus Administration. 35 substations, transformers, 6·3 kV disconnecting switches and automatic circuit-breakers, l.v. automatic cut-out switches, measuring instruments, etc. (E.S.B. 17637/56.I.C.A. Ten/20283.)*

Washington (Durham).—20th August. U.D.C. Electrical installations in 54 houses on the Coach Road housing estate. Surveyor, Council Offices.

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

ORDERS PLACED

Oxford.—Regional Hospital Board. Electrical work in connection with Stage I of modernisation of St. John's Hospital, Stone (£1,290).—N. G. Bailey & Co.

Rochdale.—Corporation. Electric lighting and power installation at the girls' technical school, Fleece Street (£1,406).—Henry Tattersall.

South Shields.—Education Committee. Electrical installation in the new school at Biddick Hall (£2,985).—J. Robinson (Newcastle).

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors.

Ascot.—Houses (60), Cheapside Road; W. H. Rowsell, architect, Bowden Road, Sunninghill.

Ashington. — County grammar school (£218,800); county architect, County Hall, Newcastle-on-Tyne.

Baldock.—Houses (105) for U.D.C. (£158,140); Gregory Housing, Ltd., 21, Farncombe Road, Worthing.

Bexhill-on-Sea. — Convalescent home (£100,000) for the National Union of Printing, Bookbinding & Paper Workers, 74, Nightingale Lane, London, S.W.12; E. Spriggs & Partners, quantity surveyors, 2, South Audley Street, London, W.1.

Billingham.—Child welfare clinic (£15,000); county architect, South Street, Durham.

Birmingham.—Additional accommodation for men and women nurses at Rubery Hill and Hollymoor Hospitals (£42,000), for Birmingham Regional Hospital Board, 10, Augustus Road, Edgbaston, 15.

Flats (160) in five blocks at Millpool Hill, with lifts; A. G. Sheppard Fidler, city architect.

Bognor Regis.—Middleton Secondary Modern School proposed at Felpham; F. R. Steele, county architect, County Hall, Chichester.

Bromley.—Flats (60), Martins Road; Lionel Kaye, town clerk, Municipal Offices.

Extensions to Girls' Technical School, Chislehurst Road (£85,000); S. Wright & Son, Ltd., builders, Lewes Road, Bromley.

Cardiff.—Flats (124) at Cornelly Street and Lydstep Crescent; city surveyor, City Hall, Cathays Park.

Chadderton.—Houses (120), Broadway site; U.D.C. surveyor, Town Hall, Chadderton, Lancs.

Chesterfield.—Houses (70) on Pevensey and Newbold estates (£100,000); borough architect.

Cumberland.—Additions to Millom Secondary School (£211,000); county architect, Portland Square, Carlisle.

Dukinfield.—Factory and two-storey office block, Bridge Street/Gate Street; Nathan Brown Proprietaries, Ltd., manufacturing chemists, Shepley Works estate, Audenshaw.

Eccles.—Offices and motor coach garage, etc., Liverpool Road, for Wheatleys Garage, New Lane, Patricroft; J. E. & J. Partington, architects, Rusland House, Regent Road, Lostock, Bolton.

Ely.—Houses (50) for U.D.C.; Gregory Housing, Ltd., 21, Farncombe Road, Worthing.

Gateshead.—Block of multi-storey flats, Melbourne Street; borough surveyor.

Glasgow.—Schools on sites 1 and 4a, at Cadder; Honeyman, Jack and Robertson, architects, Bath Street.

Guildford.—Factory, Station Meadows industrial estate; A. J. & L. R. Stedman, architects, 36, South Street.

Hereford.—Houses at Tupsley (44) and on Red Hill estate (298); borough engineer, Town Hall.

Honley.—Factory; Brook Motors, Ltd., Empress Works, Huddersfield.

Leicester.—Extensions to Lero Building for development of technical education (£195,000); city architect.

London.—Office block, 37, Cavendish Square, Marylebone; Leslie C. Norton, architect, 4, St. George Street, W.1.

Loughton.—Dwellings (43), Oakwood Hill; Tooley & Foster, architects, Midland Bank Chambers, Buckhurst Hill.

Luton.—Large factory in the area; Commer Cars, Ltd., Biscot Road, Luton.

Middlesbrough.—Houses (38) at Pallister Park; Cubitt & Son, builders, Eastbourne Road.

Houses (25) on the Pallister Park estate; Pearson and Son, builders, Borough Road West.

Morpeth.—Houses (62), Spelvit Lane; F. Perkins, borough surveyor.

Houses (119) and bungalows (35) in Choppington Road and development of 20 acres at Stobhill Grange Road; William Leech, Ltd., builders, St. James Street, Newcastle-on-Tyne.

Newcastle-on-Tyne.—Houses (46), Benton Park Road; Cussins (Contractors), Ltd., The Drive, Gosforth.

Nottingham.—Multi-storey car park; R. M. Finch, city engineer, Guildhall.

Oadby.—Shopping centre on housing estate at Brocks Hill; Calverley & Sons (Contractors), Ltd., Evington Valley Road, Leicester.

Oxford.—Girls' high school, Marston Ferry Road; Richard Costain, Ltd., builders, 111, Westminster Bridge Road, London, S.E.1.

Queensferry (Flints.).—Secondary school (£150,245), for Flints. E.C.; Salem Engineering Co., Coleshill Street, Holywell.

Redcar.—Fire and ambulance station; county architect, County Hall, Northallerton.

Reigate.—Flats (42), Green Lane estate, Redhill; borough engineer, Town Hall, Reigate.

Richmond (Yorks).—Houses (44), St. Hilary Close; John Laing and Sons, builders, Dalston Road, Carlisle.

Rotherham.—Church on the Kimberworth Park estate; J. Mansell Jenkinson & Son, architects, 18, Norfolk Row, Sheffield, 1.

Rowley Regis.—Houses (70), Corngreaves estate (£104,929); Eadie & Co. (Wolverhampton), Ltd., builders, Waterloo Road, Wolverhampton.

Salford.—Flats (130), Southgarth area; city engineer.

Scraptoft.—R.C. primary school; county architect, Leicester.

Stanley (Co. Durham).—Houses (149) at Catchgate, South Stanley and East Stanley; U.D.C. surveyor.

Stevenage.—Shops and flats (£1,131,616), for Development Corporation; Harry Neal, Ltd., builders, Head Office, 117, Baker Street, London, W.1.

Stockton-on-Tees.—Houses (161), on the Hardwick estate; borough architect, 28, The Square.

Sudbrook.—Pulp mill; Bridgend Paper Mills, Ltd., Bridgend, Glam.

Swansea.—Additional houses (330), on site at Penlan, and houses and flats (64), at Nicander Parade; R. Hudson, borough surveyor, Guildhall.

Terminal buildings for Fairwood Aerodrome; borough architect.

Swindon.—Two instalments of extension plan at Swindon College (£752,966); F. I. Bowden, county architect, County Hall, Trowbridge.

Trowbridge.—Houses (73), Rutland Crescent site; U.D.C. surveyor, Town Hall.

Tynemouth.—Methodist church in Broadway (£35,000); Alex Anderson, Ltd., Stanmore Road, Newcastle-on-Tyne.

Walsall.—Library, clinic and meeting room on Gipsy Lane estate; John H. Rendle, architect to T.C., Lichfield Chambers, 1, Leicester Street.

Warrington.—Two villas, school, staff houses, workshops and mortuary for Newchurch Hospital, Culceth; T. Noel Mitchell, architect, 88, Church Street, Liverpool.

Wellingborough.—Houses (74) in five villages; U.D.C. architect, Wellingborough, Northants.

West Bromwich.—Two-storey offices and warehouse, off Bromford Lane, for Matthews' Oils, Ltd., Bromford Lane; L. Hewitt and Meredith, architects, 117, Dale End, Birmingham, 4.

Strip mill for J. B. & S. Lees, Ltd., Albion Mills; J. J. Gallagher & Co., Ltd., builders, 28, Lea Road, Birmingham.

Weymouth and Melcombe Regis.—Houses (110), at Littlemoor; E. J. Jones, town clerk, Town Clerk's Office, Weymouth.

Wigston.—Houses (82) and bungalows (26), Lansdowne estate, South Wigston; U.D.C. architect, Wigston, Leics.

York.—Houses (88), Chapelfields estate; F. Shepherd & Son, Ltd., builders, Blue Bridge Lane.

TRADE MARKS

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to the dates stated:—

4th August

FILLERY. No. B733,113. Class 9. Floor polishing machines (domestic), vacuum cleaners and combined floor polishing, vacuum cleaning and floor scrubbing machines, all being electrically operated, and parts.—Fillerys (Great Britain), Ltd., 101-109, Ladbroke Grove, London, W.11.

HYCON. No. 747,099. Class 9. Oscilloscopes, electronic apparatus for automatically controlling the operation of cameras; camera gyrostabilisers; automatic pilots and automatic co-pilots, all operated by gyrostabilisers; electronically operated radiation indicating apparatus; and photogrammeters.—Hycon Mfg. Co., Pasadena, California, U.S.A. Address for service, c/o Stevens, Langner, Parry & Rollinson, 5-9, Quality Court, Chancery Lane, London, W.C.2.

CARMATRON. No. 748,603. Class 9. Electric oscillation generators, cathode ray tubes; and radio, telegraphic, telephonic, television and radio location apparatus and instruments.—Compagnie Générale de Télégraphie sans Fil, Paris, France. Address for service, c/o Haseltine, Lake & Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2.

CLARYL. No. 751,350. Class 9. Electric apparatus and instruments; scientific, optical, cinematographic and sound-reproducing instruments and apparatus, etc.—Société des Usines Chimiques Rhone-Poulenc, Paris, France. Address for service, c/o W. Symmons & Co., Bank Chambers, 329, High Holborn, London, W.C.1.

VORDIAN. No. 752,912. Class 9. Electrodes for electric arc welding.—Quasi-Arc, Ltd., Bridgewater House, Cleveland Row, St. James's, London, S.W.1.

INDUCTOSYN. No. 753,087. Class 9. Electrical apparatus for the measurement of angles and of linear displacements.—Farrand Optical Co., Inc., New York, U.S.A. Address for service, c/o Cruikshank & Fairweather, 29, Southampton Buildings, Chancery Lane, London, W.C.2.

PAGEANT. No. 753,324. Class 9. Radio and television apparatus and instruments and parts.—Co-operative Wholesale Society, Ltd., 1, Balloon Street, Manchester.

MAYHURST. No. B751,169. Class 11. Electric heaters.—British Thermostat Co., Ltd., Teddington Works, Windmill Road, Sunbury-on-Thames, Middx.

ASTRAM. No. 752,580. Class 11. Electric lamps.—Universal Distributing Co., Ltd., 66-68, Great Eastern Street, London, E.C.2.

11th August

CRESTON. No. B752,176. Class 7. Washing machines and drying machines, and parts.—H. Fisher (Oldham), Ltd., Pennant Street, Oldham, Lancs.

CLAROSTAT GLASOHM. No. 735,846. Class 9. Electric resistors.—Clarostat Mfg. Co., Inc., Dover, New Hampshire, U.S.A. Address for service, c/o Marks & Clerk, 57 & 58, Lincoln's Inn Fields, London, W.C.2.

PYERAD. No. 741,066. Class 9. Radio apparatus; gramophone pick-ups, microphones, amplifiers and loudspeakers; television apparatus; electric oscillation generators; electric batteries and accumulators; domestic electrical appliances; germanium diodes, transistors and semi-conducting devices for use in electric and electronic apparatus; echo sounding instruments and apparatus; and parts.

TRANSHAILER. No. B746,317. Class 9. Megaphones, microphones, loudspeakers and electric amplifiers and parts.—Pye, Ltd., Radio Works, St. Andrews Road, Cambridge.

THE LEADSMAN. No. 748,855. Class 9. Sound amplifiers and cathode-ray tubes.—Pye Marine, Ltd., Lowestoft, Suffolk.

ALCON. No. 747,833. Class 9. Solenoid operated valves for use in pipe line systems and electric switches for use in controlling the action of valves in pipe line systems.—Alexander Controls, Ltd., 141, Wood End Lane, Erdington, Birmingham, 24.

PANALARM. No. 749,368. Class 9. Electrical and electronic apparatus for use in the supervision of industrial apparatus and machinery; for automatically controlling the operation of such machinery and apparatus and for giving audible or visual warning of failures in their operation; and parts.—Panellit, Ltd., Dalston Gardens, Stanmore, Middx.

DECTRA. No. 751,081. Class 9. Scientific, nautical, surveying, navigating, radio, radar, television, signalling, teaching and measuring apparatus and instruments; and electrical and electronic apparatus and instruments.—Decca Record Co., Ltd., 1 and 3, Brixton Road, London, S.W.9.

CAVALIER. No. 752,728. Class 9. Electric vacuum cleaning apparatus and parts.—Neptric, Ltd., 73-79, Hurst Street, Birmingham, 5.

Swiss Exports in 1955

Switzerland's electrical export trade last year showed as a whole a small increase on 1954. Radio apparatus recovered to a large extent from the decline that took place in that year, while telegraph and telephone material advanced by over one-third. On the other hand there were slight declines in several of Switzerland's leading markets for power plant; these, however, were partly offset by good business in Egypt. The accompanying table shows the values of the principal classes of equipment exported to some of the chief destinations last year (Sw.fr.12.20=£1.)

Class of Goods	1955 Sw.fr. (000)	Inc.or dec. on 1954 Sw.fr. (000)
Accumulators	4,736	+ 1,119
To *West Germany*	690	+ 249
,, *France*	349	+ 106
,, *Belgo-Luxemburg*	485	− 71
,, *Netherlands*	506	+ 228
Insulators	2,645	− 785
To *Netherlands*	448	+ 23
,, *Italy*	395	+ 124
,, *West Germany*	379	+ 17
,, *Belgo-Luxemburg*	320	− 17
Meters and measuring instruments	29,639	+ 706
To *West Germany*	3,024	+ 1,160
,, *France*	2,298	− 1,133
,, *Italy*	3,246	+ 49
,, *Belgo-Luxemburg*	2,388	+ 122
,, *Netherlands*	3,173	+ 703
,, *Sweden*	2,165	+ 448
Dynamo-electric machines	116,218	− 8,317
To *West Germany*	7,402	+ 2,264
,, *France*	7,831	+ 1,828
,, *Belgo-Luxemburg*	4,086	− 3,364
,, *Netherlands*	4,533	− 1,558
,, *Spain*	4,351	− 3,772
,, *Egypt*	14,570	+ 11,920
,, *India*	3,954	+ 287
,, *Canada*	3,365	+ 1,258
,, *Colombia*	3,157	− 2,151
,, *Brazil*	5,727	− 1,877
,, *Uruguay*	5,125	+ 1,980
,, *Norway*	2,815	− 3,177
,, *Austria*	2,950	− 1,471
,, *Mexico*	2,889	− 2,544
Lighting and starting equipment for vehicles	7,770	+ 2,356
To *Netherlands*	1,152	− 89
,, *West Germany*	2,110	+ 1,415
,, *France*	1,155	+ 361
,, *Italy*	852	+ 155
Telegraph and telephone apparatus	21,303	+ 5,957
To *Netherlands*	5,092	+ 309
,, *Venezuela*	8,942	+ 4,830
,, *Israel*	1,090	+ 140
Radio apparatus	16,646	+ 4,102
To *West Germany*	1,285	+ 481
,, *France*	1,397	+ 342
,, *Italy*	1,570	+ 599
,, *Belgo-Luxemburg*	1,217	+ 200
,, *Colombia*	3,903	+ 2,335
,, *India*	847	+ 554
Unspecified electrical apparatus over 500 kg.	34,143	− 3,380
To *Austria*	1,135	− 298
,, *Sweden*	1,621	− 760
,, *Finland*	1,025	− 160
,, *Turkey*	1,100	+ 711
,, *Arabia*	1,143	+ 1,029
,, *Canada*	4,134	+ 2,242
,, *U.S.A.*	1,523	− 4,500
,, *Mexico*	2,505	+ 1,638
,, *New Zealand*	1,133	+ 527
Ditto 50–500 kg.	20,950	− 1,807
To *West Germany*	1,598	− 67
,, *Austria*	1,074	+ 148
,, *France*	1,475	− 177
,, *Belgo-Luxemburg*	1,092	− 458
,, *Netherlands*	1,445	+ 280
,, *Finland*	1,319	+ 296
,, *Brazil*	1,623	+ 783
Ditto 3–50 kg.	28,930	+ 1,869
To *West Germany*	3,570	+ 420
,, *Austria*	1,732	+ 576
,, *France*	3,335	+ 459
,, *Italy*	1,290	+ 12
,, *Belgo-Luxemburg*	1,909	− 180
,, *Netherlands*	2,643	− 75
,, *Canada*	1,330	+ 483
,, *Brazil*	1,533	+ 637
Ditto under 3 kg.	26,910	+ 5,026
To *West Germany*	2,700	+ 1,090
,, *France*	4,107	+ 111
,, *Italy*	1,765	+ 611
,, *Belgo-Luxemburg*	2,935	+ 472
,, *Netherlands*	3,398	+ 865
,, *Sweden*	1,867	+ 404
,, *Australia*	1,266	+ 459
Cables	7,318	+ 3,033